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**PENNSYLVANIA, NEW JERSEY
AND**

NEW YORK RAILROAD

NORTH RIVER DIVISION

SPECIFICATIONS AND CONTRACT


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To **University of Illinois.**

With Compliments of the PENNSYLVANIA RAILROAD COMPANY

This volume illustrates a portion of the work required for the New York City extension and station of the Pennsylvania Railroad, the latter also to be used by the Long Island Railroad which it controls. The Station will occupy an area of four city blocks, bounded by 33rd Street, 7th Avenue, 31st Street and 9th Avenue. The tracks in the station will be from 40 to 50 feet below the street surface. From the station westward there will be two railroad tracks under 32nd Street to the North River and thence, each track in a separate tunnel under the river and Bergen Hill, reaching the surface at the west face of the hill, and thence on embankment and viaduct over the Hackensack Meadow to a connection with the present line of the Pennsylvania Railroad, one mile east of Newark. The tunnels will be extended eastward from the station under 32nd Street and 33rd Street and East River, accommodating four tracks in four separate tunnels east of 5th Avenue, and will reach the surface of the ground about one mile east of the river terminating in a terminal yard. In this yard connections northward across Hell Gate and channels adjacent will be made with the New Haven System and eastward with the Long Island Railroad.



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Pennsylvania, New Jersey and New York Railroad

North River Division

NOTICE TO CONTRACTORS
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August 1, 1903.

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PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD COMPANY.
PUBLISHED OCTOBER 1, 1903.

NOTICE TO CONTRACTORS

(For American Press.)

NOTICE TO CONTRACTORS.

PENNSYLVANIA, NEW JERSEY & NEW YORK RAILROAD.

NORTH RIVER DIVISION.

CONSTRUCTION OF TUNNELS UNDER BERGEN HILL AND
NORTH RIVER.

NEW YORK, N. Y., Oct. 1, 1903.

Sealed proposals for the works necessary to the construction of various Sections of Tunnels under Bergen Hill and North River within the State of New Jersey will be received at the office of the Secretary of the Company at 85 Cedar Street, New York City, N. Y., until 12 o'clock noon on the 15th day of December, 1903.

A copy of each of the following documents:

INSTRUCTIONS TO BIDDERS,
PROPOSALS,
SPECIFICATIONS,
CONTRACT,
CONTRACT DRAWINGS,

will be furnished to intending bidders on written request, accompanied by a certified check for \$25.00 payable to the order of the Pennsylvania, New Jersey & New York Railroad Company, to be retained by the Company.

The documents above referred to will be furnished by the Chief Engineer at 20 West 34th Street, New York City, N. Y. Supplementary drawings exhibiting geological formation, so far as has been determined by borings, and records of certain experimental work, which may afford data to the Contractor, can also be seen at this address.

The Contractor's Bond will be 10% of the amount of his bid. The right is reserved to reject any or all bids.

A. J. COUNTY,
Secretary.

(For British Press.)

NOTICE TO CONTRACTORS.

PENNSYLVANIA, NEW JERSEY & NEW YORK RAILROAD.

NORTH RIVER DIVISION.

CONSTRUCTION OF TUNNELS UNDER BERGEN HILL AND NORTH (HUDSON) RIVER.

NEW YORK, N. Y., Oct. 1, 1903.

Sealed tenders for the works necessary to the construction of various Sections of Tunnels under Bergen Hill and North (Hudson) River within the State of New Jersey will be received at the office of the Secretary of the Company at 85 Cedar Street, New York City, New York State, U. S. A., until 12 o'clock noon on the 15th day of December, 1903.

A copy of each of the following documents:

INSTRUCTIONS TO BIDDERS,
PROPOSALS,
SPECIFICATIONS,
CONTRACT,
CONTRACT DRAWINGS,

will be furnished to intending bidders on written request, accompanied by a certified check for \$25.00 payable to the order of the Pennsylvania, New Jersey & New York Railroad Company, to be retained by the Company.

The documents above referred to will be furnished by the Chief Engineer at 20 West 34th Street, New York City, New York State, U. S. A. Supplementary drawings exhibiting geological formation, so far as has been determined by borings, and records of certain experimental work, which may afford data to the Contractor, can also be seen at this address.

The Contractor's Bond will be 10% of the amount of his bid. The right is reserved to reject any or all bids.

The above mentioned plans and documents may be seen at the office of Messrs. Jacobs & Barringer, 78 Gracechurch Street, London, E. C.

A. J. COUNTY,
Secretary.

INSTRUCTIONS TO BIDDERS

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

NORTH RIVER DIVISION.

INSTRUCTIONS TO BIDDERS.

Proposals must be made on the form furnished by the Company. All blank spaces in the proposal for any Section must be filled in and no change shall be made in the phraseology of the proposal or addition to the items mentioned therein.

A copy of the printed Specifications, Proposals, Contract and Contract Drawings will be furnished on written request, accompanied by a certified check for Twenty-five Dollars (\$25.00), payable to the order of the Pennsylvania, New Jersey and New York Railroad Company, to be retained by the Company.

Proposals must be in sealed envelopes, addressed to A. J. County, Secretary P., N. J. & N. Y. R. R. Co., 85 Cedar Street, New York, N. Y., and the envelopes endorsed "Proposals for Constructing Sections....., P., N. J. & N. Y. R. R." They will be received until 12 o'clock noon, 1903.

The bidder must deposit with his proposal a certified check drawn on a solvent bank in New York City payable to the Pennsylvania, New Jersey and New York Railroad Company, for an amount equal to 2 per cent. (2%) of his bid. This check will be returned to the bidder within sixty (60) days if his bid is not accepted. The check of the successful bidder will be returned to him as soon as the Contract is signed.

If a bidder wishes to withdraw his proposal, he may do so before the time above fixed by communicating his wish to the Secretary of the Company.

The plans and specifications provide for driving by the shield method tunnels under North River and tunnels by ordinary methods under Bergen Hill with cut approach, to the west end thereof all in the State of New Jersey. The bidder is desired to name prices for the work as described in the specifications and shown on the plans. Alternative propositions will be received for

the work shown in the plans as shield driven, based on plans submitted by the bidder, but such plans must conform to the following general requirements:

1. The shell of the tunnel must consist of a metal lining with concrete inside. The metal lining shall be circular in cross-section, or so braced as to give equal strength.

2. The metal lining must have sufficient thickness to resist corrosion. If not enveloped in masonry, it must conform to the Contract Drawings; if enveloped in masonry, the thickness must be at least $\frac{3}{4}$ inch if of rolled metal, and at least $1\frac{1}{4}$ inches if of cast metal.

3. The metal lining must be so designed as to be readily made watertight. If continuous structure of rolled metal, the joints may be made by riveting and caulking equal to the best boiler work. If built in rings with flange connections, all flanges after facing must be of the full thickness above required for linings.

4. If the lining metal is cast, the bolting and making of joints must equal in strength and efficiency the corresponding details on the Contract Drawings.

5. If the lining metal is rolled and provided with flange connections, the concrete inside shall contain twisted or corrugated longitudinal bars of an aggregate cross-section of at least 70 square inches.

6. The thickness of concrete inside the web of the metal lining shall be not less than $22\frac{1}{2}$ inches. The finished interior cross-section, the provisions for electric ducts and connections, drainage and other details must be the same as shown on the Contract Drawings.

7. If the metal lining is wholly embedded in masonry, the protecting masonry outside must be at least 6 inches thick. It must be placed in such a manner that all parts of the process can be inspected. Grouting from the interior through holes in the lining will not be considered masonry for this requirement.

8. The construction proposed must be in every respect equal in strength and efficiency, when completed, to that shown on the Contract Drawings, and under North River must have adequate support on piles or cylinders for the entire live load. In calculating strength, only the metal lining and the masonry inside of it will be taken into consideration. The masonry outside the metal lining will not be included in these calculations.

9. The bidder must submit, with his bid, a full description with drawings of the methods of executing the work, the general features of construction and all important details.

10. The decision of the Board of Engineers as to the adequacy of the bidders' plans and methods must be accepted as final.

11. In case the bidders' plans and proposals are accepted, all further details in the plans and methods will be subject to the approval of the Engineer, and no change in such plans and methods, or in the general plans and methods accepted by the Board of Engineers will be permitted during the progress of the work without the written permission of the Engineer.

12. If the alternative plans are accepted by the Company, the work shall be subject to the specifications accompanying the plans shown on the Contract Drawings, wherever applicable.

If contracts for Sections meeting at the shaft are awarded to different parties they will be required to make joint arrangements for the use of the shaft and adjacent ground placed at the disposal of the Contractors in accordance with the specifications.

The Schedules of Unit Prices must not be unbalanced and bids which the Company considers unbalanced may be rejected.

It is understood that the quantities given are approximate only, and that no claim shall be made against the Company on account of any excess or deficiency, absolute or relative, in the same, except as provided in the specifications and contract. Bidders are expected to examine the maps and plans, to visit the locality of the work and to make their own estimate of the facilities and difficulties attending the execution of the proposed work.

The right to reject any and all bids is reserved.

PROPOSALS

PROPOSAL FOR SECTION Gj.

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.
NORTH RIVER DIVISION.

.....

....., 1903.

TO THE PENNSYLVANIA, NEW JERSEY AND
NEW YORK RAILROAD COMPANY.

SIRS:

In accordance with your Advertisement of....., 1903, inviting Proposals for one or more sections of the work described in your Specifications and form of Contract and shown on your Contract Drawings, copies of all of which are hereto attached and, so far as they relate to this proposal are made part of it, we (or) I propose to furnish all the materials and perform all the work required in Section Gj for the unit prices and amounts given in detail in the attached form of Contract and summarized in the following tabular statement:

Description of item.	Contract Schedule No.	Quantity.		Price.		Amount.	
				\$	¢	\$	¢
North River Tunnels driven with shield— Cast iron lined.....	24	lin. feet	5,880	.....	.....	.....	.....
Screw Piles driven to a depth of 30 feet (North River Tunnels).....	25	number	116	.....	.....	.....	.....
Screw Piles driven to a depth of 50 feet (North River Tunnels).....	26	number	38	.....	.....	.....	.....
Screw Piles driven to a depth of 70 feet (North River Tunnels).....	27	number	156	.....	.....	.....	.....
Screw Piles driven to a depth of 90 feet (North River Tunnels).....	28	number	58	.....	.....	.....	.....
Weehawken Tunnel En- largements—(Shield Chambers)—In Con- crete with brick arch (to the east of Weehaw- ken Shaft).....	31	lin. feet	52	.....	.....	.....	.....
Weehawken Tunnels— In Concrete with brick arch (to the east of Weehawken Shaft)...	32	lin. feet	412	.....	.....	.....	.....
Total for Section Gj.....				.....	.....	.....	.....

The prices for tunnels driven with shields above named and stated more fully in Schedule No. 24 in the attached form of Contract are made with the understanding that concrete within the cast iron lining will be placed in air of normal pressure. If required to place such concrete in compressed air, the unit price for concrete so placed in compressed air in tunnel driven with shield is to be increased as per Schedule No. 35 in the attached form of Contract, such additional price to include additional cost of placing electric conduits, metal work and all other work necessarily required while placing concrete.

We (or) I propose to furnish screw piles driven from the North River Tunnels to depths not enumerated in the foregoing tabular statement at the unit prices per screw pile added to or deducted from at the unit prices per lineal foot as per Schedules Nos. 25 to 30 inclusive in the attached form of Contract, also to furnish cast steel lined tunnel at the price per lineal foot stated in Schedule No. 33, and cast iron lined tunnel driven without shield at the price per lineal foot stated in Schedule No. 34, all in the attached form of Contract.

We (or) I propose to furnish iron and steel castings and bolts, delivered in such quantities and at such places at or near the work as the Engineer may require, at the unit price per pound stated in Schedule No. 42 in the attached form of Contract.

If the Company elects to have the materials fully disposed of by the Contractor as stipulated in paragraph 307 of the specifications, we (or) I propose to furnish all required appliances and fully dispose of the materials at the rate named in paragraph 22 of the attached form of Contract.

If materials not shown on Contract Drawings or enumerated in the Schedules in the attached form of Contract should be required in the completed work, we (or) I propose to furnish the same, including all labor required thereon, at the unit prices named in Schedule No. 35 in the attached form of Contract.

This proposal is subject to all the conditions and requirements of your Instructions to bidders, Specifications and form of Contract. It is made with a full knowledge of the kind and quality of all the articles required and after verification of the quantities from the Contract Drawings attached hereto, and with a full understanding that the details of said plans and the quantities of the several classes of materials to be furnished and of the several classes of work to be done may be modified or changed during the progress of the work at your option, and in such case or cases, the unit prices for materials or labor named in the Schedules in the attached form of Contract will be accepted by the undersigned as a basis of payment in lieu of the gross sum or sums named herein.

We (or) I enclose a certified check payable to the Pennsylvania, New Jersey and New York Railroad Company for the sum of

 (\$.....) Dollars, being 2% of this bid.

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

If this proposal is accepted, we (or) I will within ten days after receiving written notice of such acceptance enter into contract with good and sufficient sureties for the faithful performance thereof.

(Signature)

(Address).....

(Signature).....

(Address).....

PROPOSAL FOR SECTION I.

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

NORTH RIVER DIVISION.

.....

....., 1903.

TO THE PENNSYLVANIA, NEW JERSEY AND
NEW YORK RAILROAD COMPANY.

SIRS:

In accordance with your Advertisement of....., 1903,
inviting Proposals for one or more sections of the work described in your
General Specifications and form of Contract and shown on your Contract
Drawings, copies of all of which are hereto attached, and, so far as they relate
to this proposal, are made part of it, we (or) I propose to furnish all the
materials and perform all the work required in Section I for the sum of
..... Dollars and..... cents (\$.....).
This sum is for the quantities of materials and labor and at the unit prices
named in Schedule No. 36 in the attached form of Contract.

If the Company elects to have the materials fully disposed of by the Con-
tractor as stipulated in paragraph 307 of the specifications, we (or) I propose
to furnish all required appliances and fully dispose of the materials at the rate
named in paragraph 22 of the attached form of Contract.

If materials not shown on Contract Drawings or enumerated in the
Schedules in the attached form of Contract should be required in the com-
pleted work, we (or) I propose to furnish the same, including all labor required
thereon, at the unit prices named in Schedule No. 37 in the attached form of
Contract.

This proposal is subject to all the conditions and requirements of your
Instructions to bidders, General Specifications and form of Contract. It is
made with a full knowledge of the kind and quality of all the articles required
and after verification of the quantities from the Contract Drawings attached
hereto, and with a full understanding that the details of said plans and the

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

quantities of the several classes of materials to be furnished and of the several classes of work to be done may be modified or changed during the progress of the work at your option, and in such case or cases, the unit prices for materials or labor named in the Schedules in the attached form of Contract will be accepted by the undersigned as a basis of payment in lieu of the gross sum or sums named herein.

We (or) I enclose a certified check payable to the Pennsylvania, New Jersey and New York Railroad Company for the sum of.....
.....
(\$.....) Dollars, being 2% of this bid.

If this proposal is accepted, we (or) I will within ten days after receiving written notice of such acceptance enter into contract with good and sufficient sureties for the faithful performance thereof.

(Signature).....

(Address).....

(Signature).....

(Address).....

PROPOSAL FOR SECTION K.

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

NORTH RIVER DIVISION.

.....

....., 1903.

TO THE PENNSYLVANIA, NEW JERSEY AND
NEW YORK RAILROAD COMPANY.

SIRS:

In accordance with your Advertisement of....., 1903, inviting Proposals for one or more sections of the work described in your Specifications and form of Contract and shown on your Contract Drawings, copies of all of which are hereto attached, and, so far as they relate to this proposal, are made part of it, we (or) I propose to furnish all the materials and perform all the work required in Section K for the unit prices and amounts given in detail in the attached form of Contract and summarized in the following tabular statement:

Description of item.	Contract Schedule No.	Quantity.		Price.		Amount.	
				\$	¢	\$	¢
Miscellaneous Work in Weehawken Shaft..	38	the total	sum of	.....	.....	.....	.....
Bergen Hill Tunnels— in concrete with brick arch.....	39	lin. feet	11,820.	.....	.....	.....	.....
Hackensack Portal and Approach	40	the total	sum of	.....	.....	.....	.....
Total for Section K.....				.....	.....	.....	.....

If the Company elects to have the materials fully disposed of by the Contractor as stipulated in paragraph 307 of the specifications, we (or) I propose

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

to furnish all required appliances and fully dispose of the materials at the rate named in paragraph 22 of the attached form of Contract.

If materials not shown on Contract Drawings or enumerated in the Schedules in the attached form of Contract should be required in the completed work, we (or) I propose to furnish the same, including all labor required thereon, at the unit prices named in Schedule No. 41 in the attached form of Contract.

This proposal is subject to all the conditions and requirements of your Instructions to bidders, Specifications and form of Contract. It is made with a full knowledge of the kind and quality of all the articles required and after verification of the quantities from the Contract Drawings attached hereto, and with a full understanding that the details of said plans and the quantities of the several classes of materials to be furnished and of the several classes of work to be done may be modified or changed during the progress of the work at your option, and in such case or cases, the unit prices for materials or labor named in the Schedules in the attached form of Contract will be accepted by the undersigned as a basis of payment in lieu of the gross sum or sums named herein.

We (or) I enclose a certified check payable to the Pennsylvania, New Jersey and New York Railroad Company for the sum of.....
.....
(\$.....) Dollars, being 2% of this bid.

If this proposal is accepted, we (or) I will within ten days after receiving written notice of such acceptance enter into contract with good and sufficient sureties for the faithful performance thereof.

(Signature)

(Address).....

(Signature)

(Address).....

SPECIFICATIONS

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

NORTH RIVER DIVISION.

(SECTIONS "Gj," "I" AND "K.")

SPECIFICATIONS.

Marginal notes do not form a part of these Specifications.

GENERAL DESCRIPTION.

1. These specifications relate to constructions for railroad lines between the boundary line in the North River of the States of New Jersey and New York and the west face of Bergen Hill in the State of New Jersey, a distance of about 1.80 miles. The work is divided into the following Sections:

2. Section Gj will embrace the lines extending from under the North River at Station 231 + 78 at the State boundary line in said river to Station 263 + 50 adjoining the east side of portal at the east end of the Weehawken Shaft. The length of Section Gj will be 3,172 feet, more or less. Separate single track iron tubular tunnels to be constructed by the shield method will pass under the North River to near the west end of the Section, terminating with tunnels to be built without shields, at the east end of Weehawken Shaft. Typical cross sections and other details are shown on Contract Drawings Nos. 1000, 1002, 1003, 1004, 1005, 1006, 1007, 1008, 1009, 1010, 1011, 1014, 1015, 1016, 1017, 1018, 1019, 1028, 1029, 1030, 1031, 1032, 1033, 1034, 1035, 1036, 1037, 1038, 1039, 1040, 1041, 1042, 1043.

3. Section I will embrace the sinking of the Weehawken Shaft and the concrete retaining walls around same at surface. The details are shown on Contract Drawings Nos. 1044, 1045.

4. Section K will embrace all of the work westward from the west end of the Weehawken Shaft at Station 264 + 80, passing under Bergen Hill to and including the portals in the west face of Bergen Hill and the approach for a distance of 300 feet west of the portals to Station 327, a distance of 6,220 feet, more or less. It will provide for two tracks each in a separate tunnel, the tunnels being 37 feet apart centre to centre. It will include two tunnels extending westward from the shaft to and including the aforesaid portals and approach in the west face of Bergen Hill. It will also include Miscellaneous Work in Weehawken Shaft and small cross tunnel from same. Typical cross

GENERAL DESCRIPTION—(*continued.*)

sections and other details are shown on Contract Drawings Nos. 1001, 1023, 1024, 1025, 1026, 1027, 1033, 1034, 1035, 1036, 1037, 1038, 1039, 1040, 1041, 1042, 1043, 1046, 1047, 1048, 1049, 1050, 1051, 1052, 1053, 1054, 1055, 1056, 1057, 1058, 1059, 1060.

Changes in alignment. 5. The proposed locations and grades of the tunnels and approaches are shown on Contract Drawings Nos. 1000, 1001, 1002, 1003, 1023, 1024, 1025, 1026, 1027. They are approximate only and the right is reserved to change them at any time during the progress of the work. If such changes cause an increase or decrease of quantities, the payment will be adjusted as provided in the contract, but the Contractor shall have no other claim for allowance or additional payment.

Materials indicated by borings on Supplementary Drawings. 6. The Supplementary Drawings show approximately the character of the materials at the points where borings have been made. Samples of the materials obtained from the borings can be seen at the office of the Engineer. The Company does not guarantee the correctness of classification or of the samples obtained.

GENERAL CLAUSES.

Meaning of the word: "Company." 7. The word "Company" in these specifications means the Pennsylvania, New Jersey & New York Railroad Company.

"Contractor." 8. The word "Contractor" in these specifications means each and every person or corporation who shall execute under contract any portion of the work herein specified, whether for supply of materials or for execution of the work.

"Engineer." 9. The word "Engineer" in these specifications means the duly appointed Chief Engineer of the North River Division of the Pennsylvania, New Jersey & New York Railroad Company or his successor or such representatives as the said Chief Engineer or his successor may appoint.

"Inspector." 10. The word "Inspector" where used in these specifications means the Inspector or Inspectors duly appointed by the Engineer.

"Contract Drawings." 11. The term "Contract Drawings" where used in these specifications means the plans entitled "Contract Drawing No.....," approved by the Engineer, defined in the contract and attached with these specifications to the contract and forming a part thereof.

"Mean High Water." 12. The term "Mean High Water" or "M. H. W." wherever used in the contract, specifications or plans is the plane of reference of the Rapid Transit Commission and is 41.012 feet below the bench mark of said Commission located

GENERAL CLAUSES—(continued.)

on the south side of 32nd Street about 167 feet west of 4th Avenue. It is equivalent to Elevation 300 on the Contract Drawings.

13. The works are to be commenced, carried on and subsequently maintained under the orders and directions and to the full satisfaction of the Engineer who will furnish plans, sections, drawings and detailed specifications to the Contractor. Work under direction of Engineer.

14. The right is reserved to the Engineer to change the plans whenever during the progress of the work he deems it necessary or advisable. Any increase of quantities in the finished work resulting therefrom will be paid for at the rates named in the Schedules of Unit Prices incorporated in the contract and deductions shall be made for any decrease in quantities in the finished work according to the same schedules. The Contractor shall have no further claim for additional compensation in consequence of such change in plans. Change of plans.

15. The Contractor is required to check all dimensions and quantities given on the plans and schedules and will be responsible for all errors therein which can be discovered by examining and checking the plans. Contractor to check dimensions and quantities.

16. In case of any discrepancy between the plans and specifications or in either of them the reading and decision of the Engineer as to the true intent and meaning shall be accepted by the Contractor. Discrepancy between plans and specifications.

17. Whenever any doubt arises as to the meaning of these specifications, that interpretation which in the opinion of the Engineer makes the best work is to be followed. Interpretation of specifications in case of doubt.

18. The Contractor shall employ and have present on the work an engineer skilled and experienced in the classes of work embraced in the contract and a sufficient number of assistants with suitable equipment. Contractor's engineer.

19. The Contractor shall maintain during construction an office near the shaft and portal at which he or his authorized representative shall be present at all times. Instructions from the Engineer left at this office shall be considered as delivered to the Contractor. Contractor's offices.

20. In the absence of the Contractor, the Engineer or his representative shall have authority to give such instructions as he may deem immediately necessary to the Superintendent or Foreman in charge at the point where such instructions are given, and the same shall be obeyed as though issued to the Contractor. Instructions to superintendents and foremen.

21. The plant to be installed and operated by the Contractor shall be the best of its kind for the work to be done; but if at any time the Engineer shall deem such plant insufficient or methods of operation faulty either for per- Plant and method of work.

GENERAL CLAUSES—(*continued.*)

forming the work in the manner or time required by the contract and specifications or for the security of persons or property he may order them changed or discontinued and the Contractor shall comply immediately.

Fire provisions.

22. The Contractor's engine and boiler houses are to be built of fire proof material. No combustible buildings or structures will be allowed in the vicinity of the power houses or shaft and all reasonable precautions shall be taken against fire and provisions made for the extinction thereof.

Work in compressed air to be without intermission.

23. Where work is to be done in compressed air, it shall be carried on by day and night without any interruption or intermission and with a sufficient force of competent workmen and a sufficient quantity of materials and tools to insure regular and rapid progress.

Work not in compressed air to be prosecuted day and night, except Sundays and holidays.

24. Where work is not done in compressed air, the Contractor will generally be required to prosecute the same continuously by day and night except Sundays and legal holidays, but in case of necessity or on demand of the Engineer, he shall carry it on without intermission of any kind.

MATERIALS AND WORKMANSHIP.

Piles.

Driving piles.

25. Piles which are to be left in any permanent structure shall be of Oak, Yellow, Norway or White Pine, Hemlock or Black Spruce cut from live timber not more than one year previous to driving in the work, shall be free from wind shakes, rotten knots or any indication of decay. They shall be not less than 8 inches nor more than 12 inches in diameter at the small end and shall be at least 12 inches in diameter at the large end, all measurements of diameter to be made inside the bark. They shall not deviate anywhere more than 6 inches from a straight line joining the ends. The bark shall be removed the entire length before driving. They shall be banded before driving, shall be pointed if required by the Engineer, and shall be driven until they will not penetrate more than 3 inches under 10 blows of a hammer weighing 3,000 pounds falling freely 10 feet. The piles shall be of such length that the part broomed or shaken by driving will be entirely removed when cut off at proper elevation. Only the portions of piles remaining in the work will be measured and paid for. Any pile broken while driving, or driven off of line, must be replaced by the Contractor at his own expense.

Pile shoes.

26. When required by the Engineer, piles shall have iron shoes, of a design furnished or approved by the Engineer and will be paid for at the rate named in the Schedule of Unit Prices.

MATERIALS AND WORKMANSHIP—(continued.)

Timber.

27. Wherever timber is used in the permanent work of construction, ^{Kind.} it shall conform to the following specifications for oak, spruce or yellow pine.

28. All timber used must be sound, thrifty and free from all forms of rot, ^{Quality.} splits, shakes, large, loose or rotten knots, worm eaten wood or other imperfections, tending to impair strength or durability. It must be cut from live timber not more than one year previous to placing in the work.

29. All timber used must be sawed square and full to sizes and patterns ^{Sizing.} called for, and must be saw butted at ends.

30. Whenever oak timber is specified, it shall be white oak or chestnut ^{Oak.} oak, and when sawed shall show no injurious sap.

31. Yellow pine timber shall be the "longleafed" variety, known as ^{Yellow pine.} "Pinus Palustris" and grown in Georgia or Florida. It must conform to the specifications of the Savannah Yellow Pine Association for the grades called for, which shall be either "Merchantable" or "Prime" as may be specified for the particular work for which required. No lower grade of yellow pine than "Merchantable" will be permitted for any permanent construction.

32. Whenever spruce timber is called for in the permanent work, it shall ^{Spruce.} be First Quality "Eastern" grown spruce and subject to inspection under "New York Survey" rules.

33. Quotations shall be made on both grades of yellow pine timber, furnished, framed and erected in place, including all fastenings, bolts, spikes, ^{Quotations include fastenings.} straps and treenails complete.

34. "Waterlogged" timber of any variety will only be accepted after ^{Waterlogged timber.} special inspection and specific approval in writing of the Engineer.

35. Where timber is required in foundations under masonry, it shall be ^{Timber work in foundations.} laid up as a grillage in not less than two tiers, or according to plans to be furnished by the Engineer, and the various tiers cross laid and fairly and closely bedded, and every stick thoroughly secured with blunt bolts or tree-nails as may be directed.

36. Whenever treenails are required for securing timber they shall be ^{Treenails.} either of yellow locust or white oak and not less than 1 1/2 inches in diameter. The wood from which treenails are made must be perfectly sound and free from all and every defect, and must be split true with the grain before turning or working into shape. Holes for treenails shall be bored slightly smaller than the finished treenail, so that they may be a driving fit.

MATERIALS AND WORKMANSHIP—*Timber*—(continued.)

Painting tenons,
treenails, etc.

37. The Contractor shall thoroughly paint with thick white lead all tenons, treenails or other joints as required by the Engineer.

Fastenings.

38. All fastenings required or used in timber construction shall be provided by the Contractor without any other charge, and the value of same in place in the work included in price bid, and the Engineer shall be the judge as to the quantity of same to be used.

How paid for.

39. All timber except piles will be bid on and paid for by the 1,000 feet board measure of actual contents measured in the finished structure, and the price per 1,000 feet will include the furnishing of all materials whether of iron or wood, transportation, labor of framing and erecting and all other expenses connected therewith.

Framing.

40. All framing must be done in a thoroughly workmanlike manner, and no blocking or shimming will be allowed in making joints. All bolt holes must be bored true, and those for drift bolts bored with an augur 1/8 inch smaller than diameter of bolt, in order to insure perfect fit of bolt.

Cement.

Manufacture.

41. Cement shall be Portland cement manufactured at works that have been in successful operation for at least 2 years.

Composition.

42. The cement shall be manufactured from a mixture of calcareous and clayey earths or rocks and shall contain no furnace slag, grey limestone, hydraulic lime or trass.

Delivery and storage.

43. The cement shall be delivered either in sacks or barrels plainly marked with the manufacturer's brand. The sacks or barrels shall be sound, strong and in first class condition in every respect. The Contractor for cement shall deliver it in warehouses furnished by the Company and located either on a railroad siding or near the west bulkhead line on the North River. It shall be piled about 10 feet high in carload lots or in lots of about 40 tons each. It shall be free from lumps or partly or wholly set cement. The Contractor for constructing the work shall receive it in the warehouses and remove it therefrom as required for use and shall be responsible for its safe-keeping after delivery to him.

Each carload to be
tested separately.

44. The requirements hereinafter specified will apply to each carload or its equivalent of 40 tons, and failure to meet those requirements will cause the rejection of the carload or lot of 40 tons.

Sampling.

45. Samples of cement for testing will be taken in such manner as the Engineer may direct, and the tests will be made under his immediate direction and by his Inspector.

MATERIALS AND WORKMANSHIP—*Cement*—(continued.)

46. The tests will be made on the individual samples without intermixing, and the cement must fill the following requirements: Tests made on individual samples.

47. It shall not contain more than 1 3/4 per cent. of sulphuric acid (SO_3) nor more than 5 per cent. of magnesia (MnO).

48. It shall be so finely ground that at least 90 per cent. will pass through a sieve having 10,000 openings per square inch and at least 75 per cent. through a sieve having 40,000 meshes per square inch, the wires of the sieves being respectively 0.0045 and 0.0024 inch in diameter. From one to ten tests will be made from every carload or equivalent lot of 40 tons. Fineness.

49. Mortars for tests will be mixed either by the trowel or the hands. The proper amounts of cement and sand will be determined by weight, and the water by measure. The temperature of the air and water is to be as nearly 21 deg. C. as practicable. If the mortar is to contain sand, the sand and cement will first be thoroughly mixed dry. The dry material will be placed on a glass plate, formed into a crater, and the entire amount of water added at once; the dry material will then be turned toward the center of the crater so as to absorb the water. After the water has been absorbed, the mixing of the mortar will be continued 1 1/2 minutes. Method of mixing mortars.

50. The proper consistency of mortars of neat cement will be determined with the Vicat apparatus. The mortar will be pressed by hand into a hard rubber ring about 7 centimeters in diameter and 4 centimeters high. The ring will then be placed on a glass plate and the surplus mortar removed with a trowel without shock. The consistency will be such that a plunger 1 centimeter in diameter, weighing 300 grams, gently lowered on the mortar and then released, will penetrate about 7 millimeters within 1 minute. Proper consistency of mortars.

51. The consistency of mortars containing sand will be as nearly as practicable the same as those of neat cement. Consistency of sand mortars.

52. The time of setting will be determined with neat cement mortar mixed and placed in a hard rubber ring as described in paragraph 50. A Vicat needle, 1 millimeter in diameter, loaded to 300 grams, will be lowered carefully to the surface of the mortar and then released. For a period of at least 30 minutes from the time the water for mixing is added to the cement, the needle shall penetrate to within 5 millimeters or less of the bottom of the mortar. The mortar shall support the same needle with a penetration not exceeding 5 millimeters in a period not exceeding 6 hours. The samples will be covered with a damp cloth after mixing. Time of setting.

53. Cakes formed of neat cement mortar about 3 inches in diameter, 1/2 inch thick at the center worked down to a thin edge all around on a glass plate will be subjected to the following tests: Constancy of volume.

MATERIALS AND WORKMANSHIP—*Cement—(continued.)*

(a.) The cake will remain in moist air under a damp cloth or in a moist closet until it will sustain the Vicat needle with a penetration not exceeding 5 millimeters, and then be placed in water of a temperature of 21 deg. C. for 28 days.

(b.) Another cake, as soon as formed, will be placed on a rack in the upper part of a closed vessel partly filled with water maintained at the temperature of 45 deg. C. so that the mortar will be in warm moist air while setting. After having been thus exposed for 6 hours, the cake will be immersed in the water in the vessel for 18 hours, the same temperature being maintained. Neither of the cakes thus tested shall show cracks, blowing or warping. At least one test will be made for every 40 tons of cement.

Sampling for tensile tests.

Standard sand.

Molding briquettes.

Rate of application of stress.

Required tensile strength of neat cement mortar.

Required tensile strength of mortars of 1 part of cement to 3 parts of sand.

54. At least one sample will be taken for tests of tensile strength from each 5 tons of cement delivered. Four briquettes will be made from each sample, two without sand and two containing one part of cement to three parts of standard crushed quartz by weight. The quartz shall be of such fineness that all of it will pass through a sieve having 400 openings per square inch and none through a sieve having 900 openings per square inch, the diameter of the wires to be $1/2$ the width of the opening. The briquette will be of standard form having a minimum section at the middle of 1 square inch. The mortar will be worked into the mold thoroughly by thumb pressure and finished on both sides with a trowel. The briquettes will be left in air under a damp cloth or in a moist closet for 24 hours and then immersed in water maintained at a temperature of about 21 deg. C. They will remain in the water until immediately before being broken. The strain will be applied at the rate of 400 pounds per minute.

55. One of the two briquettes of neat cement mortar will be broken by tension at the end of 7 days, the other at the end of 28 days. The tensile strength at 7 days must not be less than 400 pounds nor more than 700 pounds. The mean tensile strength of the briquettes from any one carload or equivalent lot of 40 tons, must be at least 15 per cent. greater at 28 days than at 7 days. If any sample fail to meet the requirement for tensile strength, or if the average increase in strength of the briquettes from any carload or its equivalent is less than above required, the same packages will again be sampled and tested, and a second failure will cause the rejection of the carload from which the sample was taken.

56. Briquettes containing 1 part of cement to 3 parts of sand must have an average tensile strength of at least 150 pounds at the age of 7 days, and at least 240 pounds at the age of 28 days. If the average strength of the briquettes from any carload or its equivalent is less than 240 pounds at the age of 28 days, or if more than one-fifth break at 200 pounds or less, or if the average increase in strength from 7 to 28 days for any carload is less than 25

MATERIALS AND WORKMANSHIP—*Cement*—(continued.)

per cent., the carload will be rejected. If any proportion less than one-fifth break at 200 pounds or less at the age of 28 days, while the increase in strength from 7 days to 28 days is 25 per cent. or more, the package from which these briquettes were made shall be again sampled and all of the briquettes must sustain 200 pounds or more at the age of 28 days.

57. The Engineer will make from time to time tests of tensile strength and constancy of volume extending over longer periods than 28 days; if cement so tested shows a reduction of strength with increased age, or at any time fails in respect to constancy of volume, either in water or in air, the Engineer shall have authority to prohibit the further use of that brand of cement and require that another brand be substituted. Tests at longer periods.

58. Cement injured in storage after having passed inspection tests will be rejected. Injured cement will be rejected.

59. The Contractor shall have on hand at all times enough cement for thirty-five days use. Supply of cement.

Sand.

60. Sand for mortar or concrete shall be coarse, sharp and silicious, not containing more than 0.5 per cent. of mica, loam, dirt or clay, or of all combined, and equal in quality to the best Cow Bay sand. If required by the Engineer, it shall be screened.

Broken Stone.

61. Sound rock excavated from the work may be used if hard, crystalline and practically free from mica. If a sufficient amount cannot be obtained from the work sound trap or hard limestone must be furnished. Gneiss from other localities will not be accepted. The rock must be clean when delivered at the crusher. It shall be broken by machine and screened in a rotary screen which will remove all dust and fragments which will pass through a hole $\frac{3}{8}$ inch in diameter and all pieces which will not pass through a hole $1\frac{1}{2}$ inches in diameter; all fragments between these limits will be retained. In special cases hereinafter specified the maximum size will be that which will pass through a hole $\frac{3}{4}$ inch in diameter.

Bricks.

62. Bricks shall be of the quality of vitrified paving brick. They shall be free from lime and other impurities, shall be as nearly uniform in every respect as possible, shall be hard burned so as to secure the greatest hardness, Bricks to be vitrified paving bricks.

MATERIALS AND WORKMANSHIP—*Bricks*—(continued.)

so annealed as to have the highest degree of toughness, and thoroughly vitrified so as to be homogeneous throughout. They shall be free from lamination and from fire cracks or checks of more than superficial extent.

Dimensions.

63. The bricks may be of any dimensions in ordinary use in the vicinity of New York, but shall be of uniform size throughout the work. The sides shall be rectangular, the angles square and sharp.

Sample bricks.

64. Before delivering any bricks on the work, the Contractor shall submit to the Engineer a sufficient number of sample bricks representing the kind he proposes to furnish. One of these will be retained by the Engineer for comparison in the inspection of subsequent deliveries and he will submit others to the following tests:

Absorption test.

(a.) Not less than three bricks shall be broken across, thoroughly dried and then immersed in water for 72 hours. The water absorbed shall not exceed 5 per cent. in weight of the dry brick.

Abrasion test.

(b.) A sufficient number of bricks to fill 15 per cent. of the volume of the machine shall be placed in a "rattler," which shall measure 20 inches in length and 28 inches in diameter, inside measurement. The rattler shall then be revolved at the rate of 30 revolutions per minute for one hour. The loss of weight of the bricks by abrasion shall not exceed 20 per cent. of their original weight.

Specific gravity.

(c.) The specific gravity of the brick shall not be less than $2 \frac{1}{10}$ as determined by the formula:

$$\text{Specific Gravity} = \frac{W}{W' - W''}$$

in which W = weight of brick dry,

W' = weight of brick in air after having been immersed in water 72 hours,

and W'' = weight of brick in water after same immersion.

Bricks equal to samples.

65. All bricks delivered must be in every respect equal to the samples tested. The Engineer will from time to time select samples from deliveries as made and test them for absorption, abrasion and specific gravity.

Inspection on delivery.

66. On delivery at the works, bricks shall be sorted by and at the expense of the Contractor for inspection by the Engineer or his representative, and rejected brick shall be removed from the work and its vicinity immediately.

MATERIALS AND WORKMANSHIP—(continued.)

Mortar, Grout and Concrete.

67. In proportioning materials for mortar, grout and concrete one volume of cement shall be taken to mean 380 pounds net, one volume of sand or broken stone shall be taken to mean 3 1/2 cubic feet packed or shaken down. Sand and broken stone shall be measured in barrels or rectangular boxes. Measurements in wheelbarrows will not be permitted. ^{Units for proportioning.}

68. In preparing mortar for brick or stone masonry, the specified amounts of cement and sand shall first be mixed dry to a uniform color. The water shall then be added in such a manner as not to wash out any of the cement and the mixing proceeded with until the mortar is thoroughly mixed and of uniform consistency. The proportions of cement and sand will generally be 1 to 2 1/2 by volume, but when the work is wet the proportion of sand shall be reduced as required by the Engineer. ^{Mortar.} ^{Mixing proportions.}

69. Grout will generally be in the proportion of 1 part of cement to 1 part of sand by volume. The materials shall be thoroughly mixed dry and water then added while the mixing proceeds, until the grout is of the required consistency. The mixing shall be continued vigorously, preventing the separation of sand, until the entire amount mixed is used. ^{Grout.}

70. Concrete will be in the proportion of 1 part of cement to 2 1/2 parts of sand and 5 parts of stone by volume, except in special cases where the Engineer may require different proportions. For the upper portion of walls to a depth of 9 inches below the surface and in narrow confined places, the smaller sized stone specified in paragraph 61 shall be used and the proportions of sand and stone may be reduced to 2 volumes of the former and 3 volumes of the latter to 1 volume of cement. When the proportions of sand and stone are reduced the increased cost of materials in the concrete will be determined by the Engineer and included in the estimates for payment to the Contractor. Whenever practicable the concrete shall be machine mixed; the mixing machine shall be a rotary mixer and of a pattern that will mix the concrete in batches and permit the definite measurement of the materials for each batch. When the Engineer considers it impracticable to mix by a machine, it may be mixed by hand as follows. The mixing shall be done on a platform of boards or planks securely fastened together. The mortar shall first be made as specified in paragraph 68. The broken stone, previously wetted, shall then be added and the mortar and stone turned over with shovels until the mortar is uniformly distributed through the mass and every stone is coated with mortar. ^{Concrete.} ^{Proportions.} ^{Machine mixing.} ^{Hand mixing.} ^{Wetting.}

71. Where walls of concrete masonry exceed 6 feet in thickness, masses of stone may be built in; such stone shall be clean, hard, compact and free from ^{Masses of stone in concrete.}

MATERIALS AND WORKMANSHIP—*Mortar, Grout and Concrete* --(continued.)

cracks or other unsoundness. They shall be set in at least 6 inch beds of concrete and have full bearings therein. They shall be set on their largest beds, shall be at least 6 inches apart at every point and at least 12 inches from the face of the wall. No stone shall be more than 2 feet in thickness. The large stones shall not in the aggregate exceed 15 per cent. of the total volume of the masonry containing them.

Consistency of mortar, grout and concrete.

72. The degree of moisture for mortar, grout and concrete shall be at all times as required by the Engineer or his Inspector; in general, mortar shall be plastic, grout shall be fluid enough to be pumped, and concrete shall be of such consistency that it will quake when being deposited, but not wet enough to cause the mortar to separate from the mixture.

Placing concrete.

73. Concrete shall be deposited in the work in such a manner as not to cause separation of mortar and stone. It shall be laid quickly in layers not exceeding 9 inches in thickness and thoroughly rammed with rammers of such form and material as the Engineer may approve; special shaped rammers will be required for corners and other places where ordinary rammers would not be effective. Compact, dense concrete must be obtained with all the voids between the stones filled with mortar. If voids are discovered at any time the defective concrete shall be removed and immediately replaced by concrete of such mixture and in such manner as the Engineer may direct. Contraction joints in concrete formation shall be made where the Engineer may require them. Where columns limit the thickness of "concrete" at face, the cement mortar used in conjunction with expanded metal lath is measured and paid for as concrete only.

Preparing concrete surfaces on which concrete is to be placed.

74. When the placing of concrete is suspended, the Engineer may require a joint to be formed in a manner satisfactory to him, so that the fresh concrete when added may have a bond. Before depositing fresh concrete the entire surface on which it is to be laid shall be cleaned, washed, brushed and slushed over with grout of cement without sand.

Protecting surface of concrete.

75. The surface of freshly-laid concrete shall be protected from injury in such manner and for such time as the Engineer may require; concrete injured in any manner shall be removed.

Water in mortar, etc.

76. Water used in mortar, grout and concrete shall be clean, fresh water.

Dead mortar not to be used.

77. No mortar, grout or concrete which has commenced to set shall be used anywhere in the work. Re-tempering of mortar or grout which has commenced to set will not be permitted.

Forms.

78. Forms for concrete shall be substantial and must preserve their accurate shape until the concrete has set. Where the concrete will show in the finished work, the face of the form shall be built of matched and dressed planking

MATERIALS AND WORKMANSHIP—*Mortar, Grout and Concrete*—(continued.)

finished truly to the lines and surfaces shown on the plans. Adequate measures shall be taken to prevent the adhesion of mortar to the forms. Forms which have become warped or distorted shall be immediately replaced.

79. Faces which will show in the finished work shall be true to the form intended, and shall be wholly smooth and free from ridges and cavities due to shortage of mortar at the face. Exposed faces shall have a facing of mortar 2 inches thick, deposited simultaneously with the corresponding layers of concrete and separated from the concrete by a metal diaphragm of approved form. Immediately after the mortar and concrete have been deposited the diaphragm shall be removed and the materials well worked together by spading and tamping, so as to insure their bonding. In places where this method cannot be used, as the under surfaces of arches, the same end shall be attained by methods satisfactory to the Engineer. Plastering the face after removing the forms will not be permitted. The facing mortar shall be of the same composition as the mortar used in concrete.

Facing of concrete.

Plastering not allowed.

80. Rock surfaces shall be thoroughly washed and cleaned before concrete is deposited against them. Earth surfaces shall be wetted and compacted by ramming immediately before depositing concrete thereon.

Surfaces to be cleaned and compacted before depositing concrete thereon.

81. If leaks appear on the surface of the concrete at any time after removing the form the Contractor shall remove the concrete through which the water passes and replace it with sound concrete and shall stop the leakage or conduct the water to the floor of the tunnels through channels or pipes in the concrete or take such other measures as the Engineer may require.

Leaks to be stopped.

Granitoid.

82. Granitoid is to be composed of one volume of cement to three volumes of fine clean granite screenings, approved by the Engineer.

Brick Masonry.

83. Bricks shall be immersed in water for at least 20 minutes immediately before laying; they shall be laid in full beds of mortar and all joints completely filled with the same. Joints must be broken so as to give the best bond obtainable. The mortar in beds and joints shall average about 1/2 inch. Close joints will not be permitted.

Brick laying.

84. The exposed faces of brick masonry shall be carefully cleaned and all joints not perfectly filled shall be cleaned out, well wetted and then pointed with a mortar containing equal parts by volume of cement and sand. The mortar shall be packed tightly into the joint and smoothed off with a steel tool.

Pointing.

MATERIALS AND WORKMANSHIP—*Brick Masonry*—(continued.)

Bonding in arches. 85. Where bricks are used for arches in tunnels they will generally be laid in rings, but wherever the joints in two rings come opposite, two lines of headers shall be laid so as to bond the several ring courses together.

Protect fresh work. 86. All fresh work must be carefully protected from injury.

Stone and Stone Masonry.

Quality of stone. 87. Wherever stone masonry is ordered on the work, the stone used shall be granite, trap rock, hard sand stone, hard blue limestone, or any other which has previously been approved and accepted by the Engineer for use in the work. It must be close grained and hard of texture and free from any appreciable admixture of mica. Micaceous gneiss or schists will not be permitted to be used in masonry. All stones which are exposed or visible on completion of the work, must be of uniform color and texture, and the stratification must be uniformly true so as to produce a harmonious appearance in the completed work. All stones used in masonry must be worked and prepared so as to set on their natural bed.

Color, texture. 88. The Contractor shall, before placing order for stone, notify the Engineer from what quarry it will be obtained, and the Engineer may elect to inspect the stone either in the quarry before shipment, or on the cars after delivery at the site of the work.

Natural bed. 89. Foundations of masonry below the surface of the ground or below low water mark, shall be built strictly in accordance with the following specifications, with the exception of the finish on the face, which may be left as it comes from the quarry.

Quarry inspection. 90. When rock foundations cannot be had for abutments and piers, the masonry shall on approval of the Engineer be started upon a pile foundation with a floor of squared timber sunk to such a depth as to protect it from decay and to prevent the possibility of underwashing. The timber platforms shall be composed of two or more courses, according to the depth of the water, the height of the masonry, or other circumstances of which the Engineer shall judge and determine.

Foundation of masonry. 91. Masonry shall be first class and bonded throughout.

Pile foundations. 92. The stone shall be accurately squared, jointed and bedded, and laid in courses of not less than 12 inches in thickness, regularly decreasing from bottom to top of elevation of masonry work.

First class masonry. 93. The stretchers shall in no case have less than 16 inches bed for a 12 inch course; for all courses above 16 inches, they shall have at least as much bed as face and no stretcher shall be less than 4 feet in length.

MATERIALS AND WORKMANSHIP--*Stone and Stone Masonry*---(continued.)

94. The headers shall not be less than 4 feet in length. They shall occupy ^{Headers.} at least $\frac{1}{5}$ of the face of the wall, and no header shall have less than 18 inches width of face, and where the course exceeds 18 inches in height, the width of the face shall not be less than the height of the course. Headers shall hold the size in the heart of the wall that they show on the face, and be so arranged that a header in a superior course shall be placed between two headers in a course below; but no header shall be laid over a joint, and no joint shall occur over a header. They shall be similarly disposed in the back of the wall, interlocking with those in the face when the thickness of the wall will admit. When the wall is too thick to admit of such arrangement, stones not less than 4 feet in length shall be placed transversely in the heart of the wall to connect the two opposite sides of it.

95. The length of any stone shall in no case exceed five times the depth and the width shall in no case exceed three times the depth.

96. The joints shall be cut square with the face for a distance of at least ^{Joints.} 12 inches back, except in voussoirs of arches, in which case the joints shall be cut square for whole depth shown on plan. No vertical joint shall be placed less than 12 inches from a joint in the next lower course.

97. The backing stones shall be of large size, and have parallel beds, ^{Backing.} laid so as to break joints with one another, and when the thickness of the wall exceeds 3 $\frac{1}{2}$ feet, headers of the same dimensions as those in the face shall be placed in the back of the wall, in the proportion of one for every two headers in the face.

98. The stone shall be set in Portland cement mortar, and every course ^{Cement and grout.} shall be thoroughly grouted.

99. The walls where shown on drawings shall be covered with a course of ^{Coping.} coping from 12 to 24 inches thick, well dressed, and if required fastened together with iron clamps.

100. All stones except where otherwise specified or shown on drawings, ^{Rock face.} shall have rock face, but in no case shall the projection of the rock exceed 2 inches. The four edges of each face stone shall be dressed to a plane surface 1 $\frac{1}{2}$ inch wide.

101. The arch stones shall have accurately dressed beds and joints through- ^{Arch stones.} out. And no arch stone shall be less than 3 feet in length.

102. The intrados of all the arch stones shall be axed. ^{Arch stones.}

103. The exposed face of all masonry walls shall be kept clean and free ^{Cleaning and pointing.} from dirt or cement and all joints shall be cleanly scraped, wetted and uni-

MATERIALS AND WORKMANSHIP—*Stone and Stone Masonry*—(continued.)

formly pointed with mortar containing equal parts by volume of cement and sand.

Measurements. 104. The measurements on all masonry will be taken in cubic contents to the draft lines and no allowance made for rock face.

Rock face hammer dressed. 105. The rock face must be hammer dressed so as to give a uniformly even appearance.

Vitrified Drain Pipes.

Definition of size. 106. The pipes are designated by their interior diameters.

Shape. 107. Each pipe shall be of uniform diameter and truly cylindrical.

Burning and glazing. 108. Pipes shall be of the best material, thoroughly and perfectly burned, without warps, cracks or other imperfections and shall be smoothly salt-glazed in the best manner over their inner and outer surfaces.

Lengths. 109. Straight pipes shall be in lengths of not more than 30 inches. Pipes having openings moulded into them shall be in lengths of from 24 to 36 inches.

Thickness. 110. Pipes 10 inches or less in diameter shall have a minimum thickness of $\frac{1}{8}$ inch plus $\frac{1}{12}$ of the diameter; those more than ten inches in diameter shall have a minimum thickness of $\frac{1}{12}$ of the diameter.

Joints. 111. Pipes shall be connected with hub and spigot joints. The hub shall be of standard depth and clearance.

Curved pipes. 112. When required, curved pipes shall be furnished. No curved pipe shall exceed 3 feet in length.

Matching. 113. All pipes previous to being placed in the work shall be fitted together and matched so that when joined in place they may form a true and smooth line of tubes.

Making joints. 114. Each joint as the pipes are laid, shall be filled with mortar mixed in the proportion of 1 part of cement to 1 part of sand by volume. The joints shall be carefully wiped inside and out and pointed, the pipe being left clean and smooth throughout.

Measurements. 115. Drain pipes will be measured in the work and payment made for the actual length of drain.

Vitrified Conduits for Electric Cables.

Burning and glazing. 116. The vitrified conduits for electric cables shall be manufactured of the best clay, thoroughly burned, sound in all respects, straight and free from

MATERIALS AND WORKMANSHIP—*Vitrified Conduits for Electric Cables—(continued.)*

splits, fractures, soft spots, stones, cracks or blisters tending to impair their strength or durability. They shall be thoroughly and completely glazed with good salt glaze. The interior surfaces of the duct holes shall be smooth and free from any projections or imperfections which may tend to strip the lead coating from the electric cable when pulled through the duct. The ends shall be cut smooth and square with the axis. Ends of holes shall be slightly bell-mouthed. When conduits are cut to special lengths, the cut end must be dressed with chisel and rasp until the hole is slightly bell-mouthed and has smooth edges. Special lengths. Bell-mouthed.

117. Conduits shall be of whatever form and pattern the Engineer may require, either single or multiple duct conduits. In the four-way conduits, dowel holes are to be formed at each end for truly centering the sections when laying. The standard length of single-duct conduits shall be 18 inches and four-way conduits 30 or 36 inches, as the Engineer may determine from the samples submitted. The lengths must not vary from the standard by more than $\frac{3}{4}$ inch. The duct holes in single-duct conduits shall not be less than $3\frac{1}{2}$ inches, nor more than $3\frac{7}{8}$ inches in diameter, or square with corners rounded; the outside walls and webs shall be $\frac{3}{4}$ inch thick. The outside dimensions of four-way ducts shall not exceed $9\frac{1}{2}$ inches on a side. The conduits shall be square on outer lines with corners rounded. Single or multiple duct, as required. Lengths. Diameter of ducts.

118. The adopted sample sections of conduits exhibited at the office of the Engineer shall represent in every way the conduits to be furnished by the Contractor. Samples.

119. The conduits shall be laid in about $\frac{1}{4}$ inch beds of mortar and in perfect alignment and grade throughout. The vertical joints between conduits shall be filled with mortar and the concrete carried up in layers as the conduits are laid. Dowels with central washer shall be provided by the Contractor and placed in every dowel hole. A wood mandril 3 inches in diameter at ends, $3\frac{3}{8}$ inches in diameter at the center and 4 feet long shall be threaded through each hole after the conduits have been bedded in place and the Engineer may require the Contractor to thread the mandril through a second time. A spring steel tube scraper with a flue brush behind it or other device approved by the Engineer shall be attached to the end of each mandril and used to remove all foreign matter from the duct. Laying conduits.

120. Butt joints of conduits shall be broken at every tier half the length of the section or as may be specially required by the Engineer. Every joint of the four-way conduits shall be lapped around with two thicknesses and 6 inches overlap of No. 6 cotton duck canvas 6 inches wide, 3 inches on each Making joints.

MATERIALS AND WORKMANSHIP—*Vitrified Conduits for Electric Cables—(continued.)*

abutting section, saturated with neat cement grout immediately before placing. These laps are to be doubled on curves. Single-duct conduits are to be lapped on curves only.

Closures.

121. Short sections of conduit shall be used at manholes only to effect proper bond and closures. These short sections shall be cut cleanly and truly square across without splitting the ducts. No four-way conduit section shall be cut less than 12 inches long, and no single conduit section shall be cut less than 9 inches long.

Iron bonds.

122. Where shown in horizontal joints between four-way and one-way conduits and about 36 inches from centre to centre and staggered, there shall be laid on the flat an iron or steel bond 2 inches by 1/8 inch and length as shown in plans, split and forked at each end to connect the face and back portions of the walls; or in lieu of such bonds, the Engineer may require the use of expanded metal or wire netting as shown on Contract Drawings Nos. 1009, 1010, 1011, 1031, 1032, 1033, 1034, 1040, 1041, 1042, 1043, 1054, 1060.

Paraffined plugs.

123. Paraffined wooden plugs shall be furnished by the Contractor and placed in the free ends of all ducts when work is discontinued and shall be left in place.

124. Electric conduits will be measured in the work and the unit price shall include dowels, canvas lapping and paraffined plugs.

Manholes.

125. Manholes will be built at intervals and in accordance with plans furnished by the Engineer. Iron manhole castings and covers, doors and other details as shown on the plans shall be supplied and set in place by the Contractor.

Fish wire.

126. One No. 8 B. & S. gauge galvanized iron wire shall be placed, pulled and left in each duct from manhole to manhole.

Wrought Iron Pipes for Electric Ducts.

Pipes to be wrought iron lap-welded.

127. Where iron pipes are required for electric ducts, they shall be standard wrought iron, lap-welded pipes, 3 1/2 inches diameter inside.

Bent pipes.

128. Bent pipes shall be free from distortion in cross section, and the bends shall not vary anywhere more than one inch from the form required.

129. The ends of pipes shall be smoothed and rounded with a file on the inner edges, so as not to injure the lead covering of the electric cables, when drawn through. Paraffined wooden plugs shall be furnished by the Contractor

Paraffined plugs.

MATERIALS AND WORKMANSHIP — *Wrought Iron Pipes for
Electric Ducts—(continued.)*

and placed in the free end of all ducts when work is discontinued and shall be left in place.

Flags.

130. Flags for covering drains shall be hard, sound Hudson River bluestone or slate, or other hard, durable stone acceptable to the Engineer. They shall be not less than 3 inches nor more than 5 inches thick with square joints and of exact width required by the plans. They shall be in lengths of not less than 24 inches. They shall be free from cracks, splits, soft spots or other defects and shall be dressed on the under side to give an even bearing on the side walls of the drains without the use of sand, spalls or mortar.

Clay Puddle.

131. Clay to be used as puddle is to be good stiff clay, perfectly free from sand, earth or other foreign substances and is to be thoroughly worked up in a pug mill to the satisfaction of the Engineer.

Cast Iron.

132. Cast iron shall contain not less than 1.00 per cent. of silicon, not more than 0.6 per cent. of phosphorus and not more than 0.13 per cent. of sulphur. Chemical requirements. No mill cinder, white or burnt iron or scrap of any kind will be permitted in the composition.

133. Castings shall be made with a high sinking head, so as to insure solid Sinking head. metal throughout.

134. Test bars 1 inch square and 15 inches long shall be cast and tested in Tests. their rough state. Four may be required from each ladle if the Engineer considers it necessary, but if the operation of melting is carried on continuously not more than 10 sets of 4 each will be required from any cupola during a day of 24 hours. Three bars of each set will be broken by transverse test in a suitable testing machine approved by the Engineer, the load being applied slowly; the bars being sustained on knife edges 12 inches apart and load being applied by knife edge midway between the supports. The average breaking load of 2 out of 3 bars must exceed 2,000 pounds. If the first two bars tested show that the metal passes this test, the third need not be broken. The fourth bar when resting on solid supports 1 foot apart must sustain 4 blows from a 10 pound Drop test. weight striking midway between supports, the first blow falling from a height of 12 inches and subsequent ones from heights of 13, 14 and 15 inches successively. If the bars fail to pass any of these tests, the castings represented will be

MATERIALS AND WORKMANSHIP—*Cast Iron*—(continued.)

rejected and it will be understood that the castings represented include all made between the successful tests immediately preceding and following.

Surface finish and soundness.

135. Castings must have clean, smooth surfaces, free from fins and surface imperfections. They must be neatly chiseled and wirebrush dressed before leaving the foundry. They must be sound and free from blow holes, cold shuts and flaws. Castings having blow holes plugged or puttied and those which do not accurately conform in form and dimensions to the plans will be rejected. Each casting shall have its distinguishing letter or number cast on at the place indicated on the plans.

Inspection notice.

136. The Contractor shall notify the Engineer at what foundry or foundries he will obtain castings and shall give at least three days notice in writing before any castings are manufactured in order to enable the Company's Inspector to be present. No castings will be accepted which have been shipped without such notification having been given.

Notice of shipment.

Inspection at foundry not final.

137. Inspection at the foundry will not be considered an acceptance of castings which may be found defective after they have been delivered at the work.

Weights.

138. The actual weight of any casting shall not differ more than 2 1/2 per cent. from the calculated weight. In calculating weights, the weight of 1 cubic foot will be taken at 450 pounds.

Pitch coating.

139. After being cleaned and while still hot, at a temperature of about 300 deg. F., castings shall be dipped in a bath of pitch. The pitch shall be made from coal tar, distilled until the naphtha is entirely removed and the material deodorized with a mixture of five (5) or six (6) per cent. of linseed oil. Pitch which becomes hard and brittle when cold will not answer for this use. The pitch must be carefully heated in a suitable vessel to a temperature of 300 deg. F. and must be maintained at this temperature during the process of dipping. The material will thicken and deteriorate as castings are dipped into it and fresh pitch must therefore be added frequently, and occasionally the vessel must be emptied and refilled with fresh pitch.

Oil bath.

140. If in any case it should be impracticable to dip the castings in pitch before cooling, they shall be completely coated inside and out, immediately after cleaning, with linseed oil to prevent rusting until dipped. No casting shall be dipped after rust has set in. When dipped, the castings shall remain in the pitch bath until they have attained a temperature of 300 deg. F.

Castings machined when dry.

141. After being dipped the castings shall be removed slowly from the bath and laid on skids to drip, cool and dry before being machined.

MATERIALS AND WORKMANSHIP—*Cast Iron—(continued.)*

142. All joints of cast iron tunnel linings shall be planed to correct form and dimensions. Bolt holes may be cored and must be of the diameter required; the diameter of the bolt holes shall be $\frac{1}{4}$ inch greater than the diameter of the bolts. The thickness of the flanges shown on the plans is the minimum permissible after planing. After a segment has been planed, it shall be tested by applying substantial steel templates to all planed faces, the templates to be of the exact form required, with plugs attached having the exact diameter of the bolts and sufficient length to pass entirely through the cored holes. The plugs must enter the bolt holes freely and the joints correspond exactly with the template. The templates shall be furnished by the Contractor and shall be satisfactory to the Engineer. Whenever required by the Engineer, the segments for at least three rings, after being planed, shall be bolted together, the rings lying horizontally, and when so connected the outer edge of either face of any ring shall vary nowhere more than $\frac{1}{2}$ inch from a true circle nor more than $\frac{1}{2}$ inch in length of circumference from the length required by the plans. The faces of the rings thus bolted up shall be true plane surfaces. Each segment shall be cast with a letter or figure to identify it.

Cast iron lining of tunnels; planing joints.

Templating inspection for shape and position of holes.

Marking.

143. On curves, either horizontal or vertical, taper rings shall be used, the tapers being formed by increasing the thickness of the flanges. The longitudinal joints shall be planed first; the segments forming a ring then assembled, firmly bolted together and circumferential joints machine faced. After planing, each segment shall be marked on one of the finished faces with figures cut or stamped showing the ring and position in same to which it belongs and its place therein. The segments of each taper ring shall be shipped together. A number of complete taper rings shall always be on hand at the work ready for immediate use.

Taper rings for curves.

Shipment of taper rings.

144. The faces of the bosses around the bolt holes shall be machine faced parallel to the plane of the finished joint.

Bosses to be faced.

145. The spacing of bolt holes must be so accurate that any two rings of tunnel lining or screw pile section can be bolted together in any relative position.

Spacing of bolt holes.

146. Machined faces shall have a coating of white lead and tallow before shipment.

Preservation of machined faces.

147. Shipments shall be made up of material for complete rings.

Shipment in complete rings.

148. The Company may at any time change the details or weight of the cast iron lining, and a corresponding adjustment of the contract price shall be made at the rate per pound named in the Schedules of Unit Prices.

Change of weight of cast iron.

MATERIALS AND WORKMANSHIP—*Cast Iron—(continued.)*

Screw pile sections.

149. The sections of cast iron screw piles are to be cast truly circular or so nearly so that they will pass through a true bored metal cylinder 8 feet long and of diameter 1/2 inch greater than the required diameter of screw pile sections and they shall at the same time be of the full diameter required. The true cylinder or cylinders for testing as above shall be provided by the Contractor, and each screw pile section shall be passed through same. The screw pile sections shall be everywhere of the thickness required by the Contract Drawings.

Machining of screw pile sections.

150. All the cast iron screw pile sections are to be machine faced dead square to the axis of each section.

Bolt and dowel holes in screw pile sections.

151. All bolt and dowel holes in screw pile sections are to be drilled accurately in position and this accuracy will be tested in a similar manner to that adopted for bolt holes of tunnel segments. The bottoms of dowel holes must be smooth and square with holes. The templates for testing shall be furnished by the Contractor and shall be satisfactory to the Engineer.

Bearings for heads and nuts of bolts.

152. The bearing faces for heads and nuts of bolts on cast iron screw pile sections must be machined, and on no account shall the fillets interfere with obtaining the full bearing for said heads and nuts.

Bolts and dowels for screw pile sections.

153. Bolts and turned dowels shall fit accurately and uniformly in all holes of screw pile sections.

Quantity of screw piles.

154. The numbers, weights, or total length of cast iron screw piles as given in the Schedules are estimated on the assumption of intersections of rock lines and bottoms of tunnels and that the screw piles will be driven down to elevations where in the opinion of the Engineer sufficient bearing capacity will be obtained. The Engineer may however determine to carry the screw piles down to bed rock or any depth more or less than those given in Schedules and the number of screw piles may be increased or diminished.

Payments.

155. Actual weights of all castings will be paid for on progress estimates unless their average weight exceeds the calculated weight; but no payment will be made for such excess.

Payment for excess or shortage of weight.

156. If the actual weight of castings for tunnel linings, screw piles or other parts of work is less on an average than the calculated weights, a corresponding deduction will be made from the estimates for payment; but no addition to the estimates will be made for average excess weight.

Steel Castings.

To be Open Hearth.

157. Steel castings shall be made by the Open Hearth process. They shall be free from injurious blow holes.

MATERIALS AND WORKMANSHIP—*Steel Castings*—(continued.)

158. The chemical requirements will be the same as for rolled steel.

Chemical require-
ments.

159. All steel castings shall be annealed.

Annealing.

160. Every steel casting shall be cast with two coupons for testing, each 1 inch in diameter and not less than 10 inches long, which shall be cut off after annealing. The test shall be made on a $\frac{3}{4}$ inch round turned from this coupon.

Tests.

161. The sample bar when tested will be required to develop an ultimate strength of at least 70,000 lbs. per square inch, an elastic limit of 40,000 lbs. and an elongation of 15 per cent. in two inches including the fracture, and a reduction of 20 per cent. in area. If the broken end shows a blow hole or other manifest defect the second coupon may be turned to $\frac{3}{4}$ inch and tested and its results taken instead of those of the first coupon.

Strength.

162. On finished surfaces there shall be no blow holes exceeding 1 inch in any dimension, or $\frac{1}{2}$ square inch in area. The length of blow holes cut by a straight line laid in any direction shall not exceed 1 inch in any one foot.

Blow holes.

163. The cast steel lining of portions of iron lined tunnels driven with shield shall be finished, pitch-coated, machined, tested, inspected, weighed, marked and in every other way conform to the requirements (where not otherwise specifically stated) specified for cast iron lining in paragraphs 135 to 137 and 139 to 148 inclusive.

Cast steel tunnel
lining.

164. The cast steel segments of tunnel lining which in pairs form the bore at bottom of tunnel for screw pile and screw blade are to be fitted together at the shops with taper dowel pins and bored to make a machine fit for the collar of steel sleeve, and the other faces machined as for cast iron tunnel lining, also tapped and plugged with $2\frac{1}{4}$ inch diameter brass plugs.

Cast steel bore
segments.

165. The screw point of screw pile is to be cast truly to the required shape, machine-faced, bored or drilled for dowel and bolt holes and will be tested for accuracy of shape and spacing of bolt and dowel holes as required for the cast iron screw pile sections, paragraphs 149 to 153 inclusive of specifications.

Screw pile point.

166. The actual weight of any steel casting shall not differ more than 4 per cent. from the calculated weight. In calculating weights, the weight of one cubic foot will be taken at 490 pounds.

Weights.

167. Actual weights of steel castings will be paid for on progress estimates unless the average weight exceeds the calculated weight, but no payment will be made for such excess.

Payments on progress.

MATERIALS AND WORKMANSHIP—*Steel Castings*—(continued.)

Payments on actual weight.

168. If the actual weight of steel castings is less on an average than the calculated weight, a corresponding deduction will be made from the estimates; but no addition to the estimates will be made for average excess weight.

Rolled Steel Work.

To be Open Hearth.

169. Steel shall be made by the Open Hearth process at works which have been in successful operation for at least one year. This is not intended to exclude new furnaces built in connection with existing works. Steel made in an acid furnace shall not contain more than 8/100 of 1 per cent. of phosphorus nor more than 6/100 of 1 per cent. of sulphur. If made in a basic furnace, it shall not contain more than 4/100 of 1 per cent. of phosphorus nor more than 5/100 of 1 per cent. of sulphur. These amounts shall be determined from an analysis of material from the ladle.

Chemical requirements.

Analyses of all melts.

170. Certified ladle analyses for carbon, sulphur, phosphorus and manganese will be required of all melts free of charge.

Analyses from drillings.

171. Analyses from drillings taken directly from the finished material shall also be furnished by the Contractor when required by the Engineer, and the Engineer may also have independent check analyses made at any time which shall have full weight in determining the acceptance or rejection of the material. The limit for phosphorus in analyses from drillings shall be 9/100 of 1 per cent. for acid steel and 5/100 of 1 per cent. for basic steel; the limits of sulphur remaining the same as in analyses from ladle.

Surface defects.

172. Finished steel must be uniform in texture throughout, free from ragged edges or surface imperfections of any kind, and any evidences of piping, lamination or other defects which may become apparent during manufacture shall be cause for rejection.

Variation from specified weights.

173. The variations of cross sections or weights of rolled material shall not exceed 2 1/2 per cent. from the specified cross sections or weights, except in plates more than 30 inches wide.

Stamping melt number.

174. Every finished plate, bar or shape shall be plainly stamped on one side near the middle with a number identifying the melt which shall be surrounded with a heavy circle of white paint. Rivet steel and small pieces not forming part of the calculated section of members, may be shipped in bundles wired together with the melt number on a metal tag attached.

Tensile and bending tests.

175. Tensile and bending tests shall be made on test pieces cut from the finished material representing each melt. When the same melt is rolled into several varieties or thicknesses of shapes, a test piece shall be cut from each variety and each thickness at the discretion of the Inspector. The test piece

MATERIALS AND WORKMANSHIP—*Rolled Steel Work*—(continued.)

shall be at least 18 inches long and be planed or turned parallel for the whole length. It shall have an area not less than $1/2$ square inch in cross section. The tests shall be made on a sample bar in its natural state without annealing, unless the material is to be annealed, in which case the sample bar shall be treated in the same manner.

176. Steel for bolts, rivets and dowels of screw piles shall have an ultimate ^{Rivet steel.} strength of 48,000 to 56,000 pounds per square inch; an elastic limit not less than 28,000 pounds per square inch; a minimum elongation in 8 inches of 28 per cent. with a reduction of area of 56 per cent.; and must be capable of being bent flat on itself when cold without sign of fracture.

177. Steel for plates, bars and shapes shall have an ultimate strength of ^{Plate and shape steel.} from 52,000 to 62,000 pounds per square inch; an elastic limit of not less than 28,000 pounds per square inch and a minimum elongation in 8 inches of 25 per cent. with a reduction of area of 50 per cent. It must be capable of being bent double when cold with no sign of fracture.

178. The fracture of all steel must be silky and have no crystalline appear- ^{Drifting test.} ance. Every steel plate, bar or shape must be capable of standing a drifting test by punching a hole a distance of two diameters from the edge and enlarging this hole to twice its original diameter without cracking or fracturing the material. Any material punched for use and indicating cracks from punching holes will be condemned.

179. Angles of all thicknesses shall bend flat and all angles less than $1/2$ inch ^{Angles to shut cold.} in thickness shall bend shut when cold under a hammer without showing signs of fracture.

180. The Contractor shall furnish free of charge prepared specimens for ^{Test pieces.} testing, the use of a testing machine satisfactory to the Engineer and all facilities and necessary assistance for making the tests.

181. Re-tests will be made only at the Contractor's request and it will be ^{Re-testing.} at the Engineer's discretion whether the material be accepted or not.

182. All facilities for inspection of material and workmanship, including ^{Facilities for inspection.} a suitable room for office shall be furnished by the Contractor to Inspectors appointed by the Engineer, and the Engineer and his Inspectors shall be allowed free access to any part of the plant or plants in which any portion of the material is made.

183. The acceptance of any material by an Inspector shall not prevent its ^{Rejection after acceptance.} subsequent rejection if found defective at any time before the final acceptance of the completed structure.

MATERIALS AND WORKMANSHIP—*Rolled Steel Work*—(continued.)

- Work to plans. 184. The work shall be done in all respects according to the plans and specifications furnished or approved by the Engineer.
- Workmanship. 185. All workmanship throughout, in every detail of construction, must be of the best kind now in use.
- Work to be the best that specifications admit of. 186. Where there is any doubt as to the quality of the workmanship required by the plans and specifications, it shall be the duty of the Inspector to require the best class of work which any interpretation will admit of, and in the event of any dispute as to his requirements appeal shall be made to the Engineer and his ruling thereon shall be final and binding on the Contractor.
- Storing material. 187. All material arriving at the shop shall be unloaded without delay and protected from rust by being stored under cover.
- Cleaning. 188. All material shall be thoroughly cleaned from scale, rust spots and dirt by an efficient method, leaving the material perfectly clean.
- Straightening. 189. All material must be perfectly straightened at the shop; mill straightening will not be considered sufficient.
- Templating. 190. Templates shall not be applied to material unless it is perfectly straight and they must lie flat without any distortion while marking is being made.
- Punching. 191. Rivet holes shall be punched accurately $1/16$ of an inch larger than the rivet, through dies not more than $1/16$ of an inch larger in diameter than the punch. The holes of built members must come truly opposite so that the rivets can be inserted without the use of drift pins. If any hole must be enlarged to admit the rivet, it must be reamed. If any considerable number of holes fail to match when assembled by $1/8$ of an inch or more, the inaccurately punched material may be rejected.
- Reaming. 192. Steel up to a thickness of $3/4$ of an inch may be punched without reaming, but when of a greater thickness it shall be either drilled from the solid or punched with holes $1/8$ of an inch smaller than the size of the rivet and reamed to fit the same. All reaming shall be done after the parts have been assembled, and the reamed holes must be entirely smooth showing that the tool has everywhere touched the metal.
- Punching, reaming and drilling. 193. For all important field connections such as the connection of longitudinal to transverse girders or any field connections designed to transfer direct live and dead loads, the hole shall be punched $1/8$ of an inch small and reamed to size, either by means of an iron template at least 1 inch thick, or while the parts are temporarily bolted together in the shop and match marked for erection. This provision does not apply where the plans show that connections are to be reamed or drilled in the field.
- Field connections to be reamed.

MATERIALS AND WORKMANSHIP—*Rolled Steel Work*—(continued.)

194. The diameter of the rivets shall be such as to require when heated a slight pressure to force them into the hole. The size of the rivets shall be adjusted to fill this condition. Diameter of rivets.

195. All rivets when driven must completely fill the holes and have perfectly formed heads, concentric with the rivet shank and of approved hemispherical shape. They must be driven to close bearing under the head and must be perfectly tight. Any rivet found to be caulked under the head must be cut out, whether loose or not. All riveting in shops must be done by direct acting power machines capable of maintaining pressure on the rivet when upset. Riveting.

196. In heating rivets, whether at the shops or in the field, the greatest care must be exercised to avoid "burning" or wasting the steel, as any driven rivet so burned will be required to be cut out. Rivets shall preferably be slowly heated up to a good driving heat and not raised beyond that temperature. Heating rivets.

197. Special attention must be paid to field riveting as all rivets driven in the field which are not perfectly tight will be ordered cut out and redriven together with any rivets which may be loosened in the redriving. Field riveting.

198. The heating of rivets in the field shall be done by the most modern and efficient machines in the market. The open coal blower forge will not be accepted for heating field rivets. The "Boyer" riveters manufactured by the Chicago Pneumatic Tool Company and the Oil Rivet Forges manufactured by the Rockwell Engineering Company of New York, will be accepted as satisfactory, but the Contractor will be allowed to use any other appliances approved by the Engineer. Types of forges.

199. Countersunk rivets shall be driven so as to fill the countersunk holes completely and in such a manner as to dispense with chipping as much as possible. Countersunk rivets.

200. All chipping, whether of rivets or other parts, shall be done in a workmanlike manner without breaking out of metal. Each chipped surface shall be finished off with a file. Where the material is chipped or planed out of a plate or shape, the concave corners shall be rounded off to a radius of at least 2 inches unless shown otherwise on the plans. Chipping.

201. All steel heated for the purpose of forging, bending or upsetting shall be subsequently annealed by heating to a dark red heat and allowing to cool slowly. Annealing.

MATERIALS AND WORKMANSHIP—*Rolled Steel Work*—(continued.)

Painting surfaces
which will be inac-
cessible.

Paints.

202. Before assembling, the several parts of a built up member shall be cleaned, and the surfaces which will be in contact, painted with one heavy coat of prepared red-lead paint, manufactured either by the Patterson-Sergeant Company, Cleveland, Ohio, or the Lowe Paint Co., Dayton, Ohio, and of the same quality and grade as furnished by them to, and used by the Long Island Railroad Company. The parts shall then be assembled while this paint is wet and the members riveted up.

Straightening.

203. All members must be finished straight, free of twists, bends or open joints and no straightening of any description will be permitted after a member is riveted up.

Stiffener angles.

204. All stiffener angles on plate girders shall be machined to secure a tight bearing fit with the flange angles with corners rounded to fit the fillet of these angles neatly.

Facing.

205. The ends of longitudinal girders when framed into transverse girders shall be faced true and square and to the exact length called for on the drawings.

Painting before ship-
ment.

206. Before leaving the shop each piece shall be given a coat of the paint specified in paragraph 202. Surfaces assembled together during erection shall each receive a heavy coat of the same paint before assembling, but surfaces which are to be in contact with mortar or concrete in the completed work shall not be painted.

Preservation of
machined faces.

207. Surfaces being painted must be dry. If painting is done in open air, it must be done during dry weather. All machine-finished surfaces shall be cleaned, oiled and given a heavy coat of white lead and tallow before leaving the shop.

Loading.

208. All parts shall be carefully loaded and protected from injury during erection by such means as will be satisfactory to the Inspector. After delivery of material at the work, the Contractor will be required to store it under cover on skids at least 12 inches above the ground and to keep it in good condition. He will be required to clean it before erection and to remove any paint, oil or rust from surfaces which will be in contact with mortar or concrete in the completed work, using the sand blast if the Engineer requires it.

209. Any piece showing injurious effects of rough handling may be rejected.

Painting after erec-
tion.

210. As soon as possible after erection, the structure shall be cleaned and surfaces which are not to be built into mortar or concrete shall be given two coats of such paint as the Engineer may require. Any places where the first

MATERIALS AND WORKMANSHIP —*Rolled Steel Work*—(continued.)

coat of paint may have been scraped off and the material rusted shall be cleaned and coated with boiled linseed oil before painting. No paint shall be applied until the preceding coat is dry, or in wet or freezing weather.

211. After complete erection and before acceptance by the Engineer, the Contractor must remove all false works, plant and materials used by him, and clean the entire structure of rubbish of any kind. Removal of false work.

SHAFT AND WORKING SITES.

212. The shaft in Weehawken (Section I) will be sunk in the position and built with retaining walls of concrete, according to the plans shown on Contract Drawings Nos. 1044, 1045. The retaining walls at top of shaft shall be of concrete. The concrete and forms for same shall conform with the requirements of paragraphs 67 to 81 inclusive. The walls shall, if the Engineer requires it, be built in sections about 50 feet long with contraction joints of a suitable form. The walls, or each section thereof, shall be built without stopping work so that no concrete will have obtained a hard set before the next layer is added. Faces shall be finished in accordance with paragraph 79 and the upper portion of the back of the wall shall have a similar facing extending 12 inches below the final ground surface. The coping on retaining walls will be of granitoid, finished in at least 50 ft. lengths in one operation, with a hard smooth trowelled face to the required form. The retaining walls shall be waterproofed with clay puddle as shown on Contract Drawing No. 1045, or in the manner described in paragraphs 296 to 299 inclusive as the Engineer may deem best. In the rock excavation for shaft care must be taken not to destroy or undermine the foundation of the retaining walls of shaft, and in the event of such occurring, the Contractor will be required to carry the retaining walls down to a good bearing and foundation to the satisfaction of the Engineer without any extra payment. The surface of rock on which concrete is to be laid shall be levelled off evenly and cleaned before any concrete is laid thereon. The Standard Section Lines shown on the Contract Drawings indicate the required planes of internal faces of shaft within which excavation is measured and the excavation shall at no place encroach outward beyond said lines and it must not project inwards (*i. e.*, towards center of shaft) more than six inches from said lines. In the event of rock excavations being carried beyond the limits described above, the Contractor will be required to restore the sides of the shaft to the required dimensions by concrete or as the Engineer directs, without any extra charge. The sides of the excavation are to be cut neatly to batter and no ledges where water may lodge will be permitted. The Contractor is to back-fill shaft at surface with excavated materials from same, bringing the ground up to the levels Weehawken Shaft.
Retaining walls.
Contraction joints.
Limits of excavation.
Back-filling at Weehawken Shaft.

SHAFT AND WORKING SITES—(*continued.*)

shown on Contract Drawings Nos. 1044, 1045, finishing up with at least two feet of gravel. The stream at the West end of this shaft is to have its waterway maintained clear and the banks of same on completion of work left unobstructed.

Miscellaneous Work in Weehawken Shaft.

213. The Miscellaneous Work (Section K) in Weehawken Shaft which includes the cross tunnel, masonry portals, electric conduits, steel and concrete formations, etc., shall be done in accordance with Contract Drawings Nos. 1033, 1039, 1040, 1041, 1042, 1043, 1046, 1047, 1048, 1049, 1050, 1051, 1052, 1053, 1054, 1055, 1056, 1057. The excavations behind the benches carrying the electrical ducts must be taken out to permit of at least the full section of concrete wall being obtained. A catch gutter of iron and concrete is to be fixed on the slopes of shaft as shown on Contract Drawings Nos. 1050, 1054. The rock is to be neatly cut to receive this gutter, and should the Contractor cut or break away more than is necessary for this he shall make it good and fix the gutter to the satisfaction of the Engineer. This Miscellaneous Work shall be done when and where the Engineer may direct and the Contractor for Section Gj shall be required to dispose his working arrangements as the Engineer may think best and consistent with the expeditious carrying out of the work; but the Contractor for Section K in the execution of this work shall in no way interfere with the working arrangements of the Contractor for Section Gj, except under the specific instructions of the Engineer. On the completion of the work the Contractor for Section K shall assume the obligations of maintenance of this shaft for the period stated in contract.

Catch gutter.

Apportionment of Weehawken Shaft to Contractors.

214. As hereinafter described in this and paragraphs 286, 288 and 306, two-thirds of the area of the Weehawken Shaft at grade level and a heading or tunnel through Bergen Hill will be turned over to the Contractor for Section Gj for use in the execution of the work in that Section, and the remaining one-third of shaft to the Contractor for Section K for similar use. The area assigned to the Contractor for Section Gj will include a clear way through the shaft to one or the other of the Bergen Hill tunnels. The apportionment of this area is to be made in a manner which the Engineer considers most conducive to the progress of the works as a whole, and will be changed in location or shape but not in area, on the change of occupancy of the Bergen Hill tunnels for the disposal of spoil, as elsewhere described. The Contractors shall at all times during the execution of their work, maintain the portions of the shaft or tunnels assigned to either of them in a clean and proper condition. The Contractor for Section K will assume the maintenance of this shaft and other works done by him which may have been temporarily occupied by the Contractor for Sections Gj and K, as provided for above. The areas at the surface adjacent to the shaft available for use by the Contractors for Sections Gj and K will be pointed out by the Engineer.

Ground for Contractors' plant.

SHAFT AND WORKING SITES—(*continued.*)

215. The area available as a working site for use of Contractor for Section K at the portal on west side of Bergen Hill will be pointed out by the Engineer. Working site at portal.

TUNNELS DRIVEN WITH SHIELDS.

216. The Contractor must provide at the shaft an adequate plant, including boilers, air compressors, hydraulic machinery, dynamos and all other necessary plant, with a reasonable duplication to meet unusual and unexpected emergencies. Plant at shaft.

217. The air compressors shall be of sufficient capacity to deliver regularly into each heading at least 300,000 cubic feet of free air per hour at a pressure of 50 lbs. per square inch above the normal air pressure and for a larger amount if found necessary during the progress of the work. The air for the compressors must be drawn from the exterior of the power house and the intake so located as to give pure cool air. The air shall be further cooled, and oil and other impurities removed as completely as practicable before delivering it into the headings. Capacity of compressors per heading.
Air to be cooled.

218. In order to provide a reasonable margin for repairs and contingencies, a spare compressor and boiler plant shall be provided at the shaft and kept in good condition and repair, ready for immediate use. The capacity of the spare plant shall be 25 per cent. of that required in the preceding paragraph for regular operation. Spare boiler and compressor plant.

219. Provision must be made for storing in tanks at each boiler house enough feed water for 12 hours supply unless connections can be made with two independent and sufficient sources of supply. Water supply.

220. The air shall be delivered into each heading through two supply pipes of such capacity that the velocity of air through them in regular working shall not exceed 40 feet per second. These pipes shall be tapped with regulating valves in each intermediate air chamber in tunnels and sufficient air admitted to ventilate it and to maintain the pressure required. If required by the Engineer, air shall be delivered at the shield in each section or compartment thereof where men are employed, and withdrawn therefrom in special exhaust pipes, with suitable regulating valves. Air supply pipes.
Air supply to intermediate chambers and headings.

221. Each supply pipe shall be furnished with two tees with valves and an intermediate valve in the supply pipe at some convenient place between the compressors and the shaft to enable a by-pass to be formed. By-pass at plant station.

222. A foul air vent pipe 8 inches in diameter shall be carried back from the shield through each lock bulkhead to the ordinary atmosphere to ventilate the Vent pipe from shield.

TUNNELS DRIVEN WITH SHIELDS—(*continued.*)

heading and shall be provided with a 10 inch pressure regulating valve near the shield to maintain the pressure required; the valve shall be so placed as not to be readily tampered with.

Ventilation and
purity of air.

223. Effective means shall be used to secure proper ventilation. The amount of carbonic acid at any working face or in any chamber must never exceed one part in one thousand parts of air, and compressors must be run so as to maintain at all times a change of air through the pressure regulating valves. Suitable devices shall be used to deaden the noise of air introduced and exhausted as much as practicable. When blasting is resorted to, special means must be provided for the rapid removal of the fumes produced.

Deaden noise of air.
Blasting fumes.

Bulkheads and air
locks.

224. Bulkheads shall be built in each tunnel at intervals not exceeding 1,000 feet and there shall at no time be an interval of more than 1,000 feet between a shield and the bulkhead nearest to it. They shall be of concrete or of brick set in Portland cement mortar. Each bulkhead shall be provided with two air locks near the bottom at least 6 feet in diameter and 20 feet long for the passage of men and materials, one near the roof as an emergency lock for the passage of men only and a pipe lock 12 inches in diameter and 31 feet long with a gate valve at each end for passing pipes and rails. The emergency lock shall be of ample dimensions to contain the entire force employed at any time at the heading. Stairways and galleries extending the full length of the forward air chamber shall always be maintained to give convenient access thereto and for the purposes of setting out lines and inspection. All parts of bulkheads and air locks must be of sufficient strength to sustain safely a pressure of 55 pounds per square inch.

Material locks.

Emergency lock.
Galleries.

Strength.

Pipes through bulk-
heads.

225. The pipes necessary for air supply, ventilation, hydraulic and electric transmission and other purposes shall be built into the bulkheads and provided with suitable connections. All pipes shall be standard lap-welded.

Number of bulkheads.

Removal of bulkheads.

226. When a shield has been driven 500 feet or more from the shield chamber, at least two bulkheads shall always be in use. No bulkheads shall be removed until a third one has been built and put in operation.

Safety screens.

227. A safety screen extending from the roof downward into the tunnel, of design approved by the Engineer shall be maintained within 100 feet of each working face and others shall be built at intermediate points between the working face and the nearest bulkhead if necessary to maintain a chamber filled with compressed air along the tunnel roof and give access to the emergency lock.

Shields.

228. The shields must be of ample strength and of the best materials, must be provided with hydraulic rams of sufficient power to move them with

TUNNELS DRIVEN WITH SHIELDS—(*continued.*)

facility along the alignment laid down on the plans and profiles and must have adequate arrangements for the rapid execution of the work and for the safety of the men employed therein. The Contractor will be required to make use of the most effective devices in the construction and operation of the shields.

229. Detailed plans and specifications of the shields, hydraulic presses, fittings and other appliances must be submitted to the Engineer before beginning their construction, modified or amended if required by him, and then built under the inspection of the Engineer in exact accordance with the plans in every respect. Such submission of plans to the Engineer shall in no way affect the sole responsibility of the Contractor for their adequacy for the purpose intended. Drawings of shields.

230. The shields are to be erected in enlarged sections of the tunnels (shield chambers) lined with cast iron. The enlarged sections shown on the Contract Drawings are of the least dimensions that will be permitted; if the Contractor should prefer, he will be allowed to increase the size of these chambers, provided that he does not encroach on private property and that the modified design is satisfactory to the Engineer and that the Contractor is not to be paid a greater amount per lineal foot than for the enlarged sections shown on the Contract Drawings and stated in the schedule of prices. The bulkheads or stopwalls closing the spaces between the enlarged sections and ordinary tunnel sections shall be formed either with special castings or with brick or concrete masonry as the Engineer may require. Before moving the shield forward after erecting it, the standard cast iron lining shall be built up temporarily within the enlarged section and within the tail of the shield to perfect shape, alignment and grade to start the permanent lining from and to form a thrust bearing for the shield. After moving the shield out of the enlarged section, all of the cast iron linings thus temporarily placed shall be removed and the section filled in to the normal cross section as required by Contract Drawing No. 1029. Erection of shields in enlarged sections.

231. The shield must be driven and the tunnel built on the alignment and grade required by the plan; any work not so built must be removed and replaced by the Contractor and he shall be entitled to no extra compensation therefor. Payment.

232. General information regarding the Fowler Warehouse adjoining Piers B. and C., Erie R. R. Yard, Weehawken, under which the iron-lined tunnels driven with shields are to pass, will be given by the Engineer. Starting of shields.

233. When material is met requiring blasting, it shall be done with small charges. When the excavation is wholly or partly in rock, enough shall be Accuracy required in driving shield.

Tunnels under the Fowler Warehouse.

Blasting ahead of shield.

TUNNELS DRIVEN WITH SHIELDS—(*continued.*)

- removed to permit the forward movement of the shield on the established line and grade without coming into contact with the rock. The invert shall be leveled up with concrete formed to the exact grade of the required excavation and the exact form of shield, to serve as a cradle therefor. If the Engineer considers it necessary, steel rails or plates shall be laid to slide the shield upon. The cost of the concrete and steel rails or plates is to be included in the price for excavation.
- Shield in rock.
- Cradle for shield.
- Support of soft ground. 234. The Contractor shall at all times securely and efficiently support soft ground ahead of shield and overlying rock, and on no account shall any ground be allowed to fall, move or flow loosely towards the shield.
- Explosives. 235. The explosives used must be of such composition as to give off the least possible quantity of injurious fumes.
- Cleaning castings. 236. The machined surfaces of castings shall be thoroughly cleaned and any abrasions of the pitch covering made good immediately before erecting the segments in the tunnel.
- Replacing imperfect castings. 237. If at any time any castings become broken or are found defective, they shall be taken out and replaced by sound ones.
- Breaking joints. 238. The successive rings shall break joints at least 18 inches.
- Thrust from shield. 239. In driving the shield, no pressure shall be brought on the circumferential flanges of the lining segments.
- Caulking joints of lining. 240. The caulking recesses between the flanges of the cast iron or cast steel linings shall be scraped out, cleaned and washed with a jet of water under a pressure of at least 50 pounds per square inch, and then caulked with a cement of iron borings and sal-ammoniac mixed in proportions of 400 of the former to 1 of the latter, by weight. The joints shall be made absolutely water-tight.
- Rust mixture.
- Bolts, washers, fillets and grummets. 241. Bolts and nuts for the joints of the cast iron or cast steel lining shall be of soft steel, forged from the solid, without welding and the bolts shall project at least $\frac{3}{8}$ inch outside the nut when screwed up in place in tunnel. Heads and shanks must be correctly formed, smooth and free from fins. Heads must be square with the bolts. Screw threads shall be U. S. Standard and rolled or pressed to full threads. Bolts shall be capable of bending when cold 180 degrees flat on themselves without crack or flaw. Each bolt shall have a close fitting wrought iron washer under the head and nut, and grummets approved by the Engineer under the washers. When the bolts are firmly screwed up the bolt holes must be absolutely water-tight.
- Specifications of bolts.
- Bolts water-tight.
- Change in method of making joints. 242. The Engineer will have the right to make any change in the method of obtaining a water-tight joint which experience may suggest and the Contractor shall carry it out.

TUNNELS DRIVEN WITH SHIELDS—(continued.)

243. The Engineer may require the Contractor to supply cast steel tunnel linings, where not herein specified, in lieu of cast iron. The cast steel lining is shown on Contract Drawings Nos. 1007, 1008. Payment for cast steel lining will be made at the rates named in the schedules and deductions will be made at schedule rates for the cast iron tunnel lining displaced by it.

Cast steel tunnel linings where not shown.

244. In each tubular tunnel at or near the intersection of grade and rock line, the Contractor shall substitute for an iron ring of tunnel lining a ring within a ring each of mild steel, forming a sliding sleeve to permit of any lengthening or distortion that may tend to occur there, owing to the difference of the ground as bearing material. This sliding tunnel ring shall be made and erected in accordance with Contract Drawing No. 1016 or any modification thereof the Engineer may think best to adopt. It shall be kept watertight during the progress of the work and the subsequent period of maintenance provided for in the contract by means satisfactory to the Engineer. Sliding rings will be paid for at rates named in the schedules, and deductions made at schedule rates for the cast iron tunnel lining displaced by them.

Sliding rings.

Payment for sliding rings.

245. In placing the segments of tunnel lining, the cast steel bore segments at the bottom through which the screw pile will pass, shall be placed first and in perfect alignment and shape and will be held in proper relative position by steel dowels, fitting accurately in drilled holes as shown on Contract Drawing No. 1014. Any modifications of these castings accessory to placing them in true alignment shall be subject to the approval of the Engineer and without extra cost to the Company.

Placing cast steel bore segments.

246. Cast iron plugs formed in two pieces as shown on Contract Drawing No. 1017, must be furnished by the Contractor to temporarily fill the holes in the cast steel bore segments through which the screw pile will be driven subsequently. These plugs will be considered a part of the Contractor's plant. Each plug must be carefully placed and wedged up to transmit thrust uniformly around the tunnel lining. It will not be removed until immediately before the screw pile is to be placed.

Cast iron plugs.

Plugs are Contractor's plant.

247. The screw piles are to be driven or screwed down through the bottom of the tunnel lining in correct position and at such times and places as the Engineer thinks best in the interest of the work. They shall be driven to such depths as specified from time to time by the Engineer who may require them to be driven to bed rock.

Driving screw piles.

Screw piles to bed rock.

248. While the screw piles are being driven, they shall be loaded by hydraulic pressure or otherwise, in such manner and to such extent as the Engineer may require.

Loading screw piles while driving.

249. Each screw pile after driving shall be submitted to a test load to the satisfaction of the Engineer by hydraulic pressure or otherwise, previous to acceptance.

Testing screw piles.

TUNNELS DRIVEN WITH SHIELDS—(*continued.*)

- Short screw piles. 250. Where screw piles are driven to a comparatively shallow depth, the Engineer may require the Contractor to drive a sleeve, of somewhat similar design to the screw pile sleeve elsewhere described, down to the bed rock; the rock shall then be dressed off to give a solid and uniform bearing for the screw pile, and in such case, the Engineer may adopt piles without screw points. The material will be excavated from inside the sleeve and the screw pile shaft put down to the required solid foundation on rock and filled solidly with concrete. In such cases the screw piles will be paid for at the rates for the various materials in place and the price for bedding same on rock as per schedule in contract.
- Bedding piles on rock.
- Payment.
- Borings at screw piles. 251. Should the Engineer wish to ascertain the nature of the ground in which a screw pile has come to rest or is being driven through, the Contractor shall put down a boring tube and obtain dry samples of the ground and if necessary blast away any boulder that may be obstructing the downward progress of the screw pile. The Contractor shall furnish all tackle, power and labor necessary for making the borings. For this work he will be paid the net cost of labor plus 15 per cent.
- Payment for borings.
- Top section of screw piles to be withdrawn and special sections furnished. 252. As the lengths of screw piles cannot be definitely predetermined it will be necessary to withdraw the top section of all screw piles and fix in its place a special section of the proper length.
- Delivery of special sections. 253. The Contractor must provide for the delivery of these special sections within three days from the date of order, which will be issued as soon as the exact length required is determined.
- Screw pile sleeves. 254. To enable the top section of a screw pile to be withdrawn and the special one substituted a thin steel sleeve will encase the screw pile at the top to a depth sufficient to form a bulkhead to retain the ground during the operation. The collar or upper portion of the sleeve which is thicker will be turned to fit within the bore of the cast steel segments. Previous to the setting of the sleeve, a temporary cast iron collar will be furnished by the Contractor as part of his plant and will serve to guide the screw pile and maintain it centrally so that the sleeve collar may be easily placed in position when the screw pile is driven to a sufficient depth to permit it.
- Collar of sleeve.
- Temporary cast iron collars.
- Dowels. 255. The dowels of rolled steel for connecting screw pile sections are to be neatly and accurately cut square and clean and turned to the exact diameters required.
- Watertight at head of screw pile. 256. The head of screw pile at junction with cast iron tunnel lining is to be made thoroughly watertight and the slot between tunnel segments for passage of screw blade is to be stopped with an iron "filler" casting and made watertight by rust jointing.
- "Filler" casting.

TUNNELS DRIVEN WITH SHIELDS—(continued.)

257. It is assumed that the ground will rise within the screw piles to about the heads of same. This ground shall be removed in every case to a depth within the screw pile of 12 feet and the screw pile filled with concrete up to the underside of the steel diaphragm plate. A wrought iron pipe 2 inches in diameter for grouting shall be built in the centre of the concrete column, extending vertically through it. The steel diaphragm plate shall be bolted down and through the grouting hole in same and 2 inch pipe, cement grout shall be injected under a pressure of at least 100 lbs. to the square inch. Should the Engineer consider it necessary to excavate the ground from within the screw pile to a greater depth than 12 feet and replace it with concrete the same shall be done and payment made therefor at Schedule rates.

Concrete within screw pile.

Grouting in screw pile.

Excavation within screw pile and payment for.

258. The work of sinking the screw piles shall be done in compressed air, and as it probably cannot be done simultaneously with the driving of the tunnels with advantage to the progress of the work as a whole, the bulkheads in each tunnel shall be left intact, removing only and temporarily the drumheads or doors of locks, until compressed air between either of the bulkheads for the above mentioned purpose is again installed.

Driving of screw piles in compressed air.

Bulkheads to remain.

259. In measuring the screw piles for payment the length shall be taken from the extreme point of the screw pile to the top of the diaphragm plate.

Measurement of screw piles for payment.

260. The Schedule prices of screw piles placed in the permanent work are to include all bolts and dowels, also the steel sleeves, diaphragms, packing rings, as well as the disposal without further cost to the Company of any materials displaced by the screw pile which may come into the tunnel.

Price to include bolts, dowels, etc.

261. During the process of screw pile driving the tunnel lining shall be diligently attended to, maintaining the bolts of the tunnel lining at all times tight, and any bolts or bolt holes used temporarily for screw pile driving purposes shall immediately on the completion of such use be restored to proper condition.

Tunnel lining and bolts thereof to be protected during screw pile driving.

262. The concrete troughs surrounding the heads of screw piles shall be formed with sloped and ragged sides to make a bond for additional concrete, in conformity with the dimensions shown on Contract Drawing No. 1004.

Concrete troughs.

263. The screw pile driving machinery and accompanying tackle shall be of the best materials and workmanship and of ample strength, and adequately arranged for the rapid placing of the screw piles. Detail plans and specifications of this plant must be submitted for the approval of the Engineer before the plant is made and the construction of same shall be subject to his inspection; such approval by the Engineer shall in no way affect the sole responsibility of the Contractor for the adequacy of the plant for the purpose intended.

Screw pile driving machinery.

TUNNELS DRIVEN WITH SHIELDS—(continued.)

Payment for screw
piles.

264. Screw piles will be paid for per screw piles of fixed lengths with deductions from or additions to same per lineal foot of screw pile as stated in schedules.

Grouting outside
lining.

265. Each segment of the tunnel lining shall have a hole near the center for grouting, which hole shall be closed by a screw plug. As soon as the Engineer considers it practicable after a ring of tunnel lining has been placed and the shield advanced beyond it, the hole shall be opened and grout shall be forced into the surrounding materials by means of a suitable machine which will mix the grout continuously and permit the application of a pressure of 60 pounds per square inch in excess of the external water pressure. Sufficient grout shall be used to fill all voids outside the cast iron lining and to form a shell having an average thickness of 3 inches. Where the tunnel is driven wholly or partly in rock, the grout shall fill all voids between the cast iron lining and undisturbed rock or concrete trough, whatever their extent may be. When the grouting is completed, the plugs shall be replaced and screwed up tight. Plugs will be paid for as part of the tunnel lining. Payment for grouting will be on the basis of cement used at the rates named in the schedules in the contract, these rates including sand, labor, plant and all other things required for the completing of the grouting and being in full payment therefor.

Pressure for grouting.

Payment for
grout.

Engineer may omit
grouting if
unnecessary.

266. The Engineer may omit the grouting wherever he considers it unnecessary, and in such case the contract price for completed tunnel will be reduced by the amount stipulated in the schedules for grouting.

Placing concrete
lining, conduits, etc.
in compressed air.

267. It is expected that the concrete lining with the conduits for electric wires, etc., will be placed after the removal of air pressure, but if the Engineer considers it necessary in any case, the Contractor shall place it in compressed air as the driving of the tunnel proceeds and as near the working face as the Engineer may require. For such work the Contractor will be paid the price named in the schedule for concrete laid in compressed air and within the cast iron lining of tunnels driven with shields, and such unit price for concrete shall also include the cost of placing electric conduits, ladders and all other things built into the concrete, for which no other payment will be made. Immediately before placing concrete the exposed faces of the cast iron tunnel lining shall be cleaned from mud and dirt.

Payment for.

Cleaning cast iron
linings.

Drainage.

268. Where screw piles are used the bottom concrete formation of the tunnel is to be sloped so as to lead to the screw pile troughs in the concrete. The cast iron drains are to be laid with a true uniform fall towards the lowest point of tunnel grade and in single lengths between the screw pile troughs.

Manholes in cast iron
lining.

269. In the cast iron lined tunnels under the River, the Contractor shall place in each tunnel 4 sets of cast steel manhole segments with cast iron plugs suitable for withdrawal, in positions to be pointed out by the Engineer. The Schedule price for these cast steel segments is included in the price for cast steel lining in Schedules of contract and the price of the cast

TUNNELS DRIVEN WITH SHIELDS—(continued.)

iron lining displaced by same will be deducted. The cast iron plugs filling these manholes will be similarly paid for as ordinary cast iron lining of tunnels. For details of manhole segments see Contract Drawing No. 1018.

270. Whenever required by the Engineer, the Contractor shall remove the air pressure in order to test the strength of the work; and if any weakness or break results, the Contractor shall make it good at his own expense and in such manner as the Engineer may direct.

Testing structure by removing air pressure.

271. The Contractor shall provide, subject to the approval of the Engineer, electric lighting for all parts of the work and plant, including lights for the Resident Engineers' office near the shaft and such special lights or groups of lights as the Engineer may require in connection with surveys; telephone communication from each heading and lock to the power house and office of the Resident Engineers near the shaft; an 8½ inch air pressure gauge at each lock bulkhead and on the 8 inch foul air vent pipe at each shield; a recording air pressure gauge on each main between receiver and shaft to be locked and the key kept by the Engineer; elevators for lowering men and materials into and lifting them out of the shaft; suitable quarters near the shaft where the men can change their clothing, bathe and be warmed on coming out of compressed air; a compressed air hospital lock at the shaft at least 6 feet in diameter with two chambers where men can be subjected to the regular working pressure if attacked by caisson disease; suitable sanitary conveniences wherever the Engineer may require and competent medical attendance for the working force. The quarters for the use of men employed in compressed air shall be provided with hot and cold water, facilities for bathing, drying clothing, hot coffee at all times, and shall be continuously under the care of attendants specially employed for the purpose. The physicians shall have an office at the shaft as near the men's quarters as practicable, fully supplied with medical stores, and at least one physician with necessary staff shall always be present. The medical appointments shall be subject to the approval of the Engineer.

Lighting, etc.

Telephones.

Recording pressure gauges.

Elevators.

Quarters for men.

Hospital lock.

Sanitary appliances.

Hot and cold water.

Physicians.

272. The Contractor shall employ no person in compressed air unless such person has passed an examination by a duly qualified physician in regard to fitness for such work.

Examination by physicians.

273. The Contractor shall supply steam for heating the quarters of the Engineers near the shaft, compressed air for operating the Engineers' hospital locks, and hot and cold water as required by the Engineer.

Heating Engineers' quarters.

274. The Contractor shall install and maintain electrical or other mechanical haulage for the conveyance of spoil and construction material between the headings and shaft, or for the operation of other machinery in tunnels, the system being such as to emit no noxious gases. The use of horses or mules in compressed air will not be permitted.

Mechanical haulage.

Horses not allowed.

TUNNELS DRIVEN WITH SHIELDS—(continued.)

Records to be kept by Contractor and furnished to Engineer.

275. The Contractor shall keep a continuous record of revolutions of each compressor, pressures in air receivers, pressures in hydraulic machinery and movement of each shield, and shall furnish the Engineer each day a copy thereof. The revolutions of compressors shall be registered by revolution counters. The pressures in air receivers shall be registered continuously.

Continuous recorders.

Clay blanket on bed of river.

276. If in the opinion of the Contractor it becomes advisable, he may at his own expense deposit on the bed of the river or in a channel or channels excavated therein, blankets or masses of clay to reduce leakage of air from the tunnels; but no such measure shall be taken without the previous consent of the Secretary of War, and if taken shall be subject to such restrictions and regulations as the Secretary of War may impose.

Payments and measurements for progress estimates.

277. Payment for completed sections of tunnel will be made on progress and final estimates at the rates named in the contract. Payment will also be made on progress estimates for tunnel driven, lined with cast iron and grouted but not lined with concrete, at the prices named in the Schedules of Unit Prices; such partial payment shall in no way relieve the Contractor from his obligation under the contract to complete and maintain the work; the amounts of excavation are calculated by multiplying the area of the cross-section of the tunnel within the exterior surface of the cast iron lining as shown on the Contract Drawings by the length of the lining. No excavation in advance of the completed lining will be estimated, nor will any payment be made for materials brought into the tunnel from outside of the cast iron lining.

Method of measurement of excavation.

TUNNELS DRIVEN WITHOUT SHIELDS.

Masonry and rock packing.

278. Where tunnels are built of concrete masonry or steel and concrete, the concrete shall be built solidly against the rock, and where brick masonry is used in arches a minimum thickness of four inches of rock packing is to be built outside the same to insure drainage of water where shown on plans and where the Engineer may deem it necessary.

Neat Lines—definition of.

279. In all cases the minimum thickness of masonry lining or combined masonry lining and rock packing will be defined by the Neat Lines shown on Contract Drawings, and will be increased wherever the Engineer may deem it necessary. Such an increase in thickness will cause a corresponding displacement outward of the neat lines which in every case define the minimum thickness of masonry or combined masonry and rock packing required.

If thickness of masonry is increased.

280. Excavation outside of the neat line must be avoided as far as practicable and in rock sections loose or shattered rock must be removed and replaced by masonry or by rock packing, as the Engineer may require. In earth sec-

TUNNELS DRIVEN WITHOUT SHIELDS—(continued.)

tions the excavation must be large enough to permit building masonry to the full required thickness clear of any timber which it may be necessary to build in, and all voids between excavation or timbering and masonry are to be filled in with concrete and grouted up tight; the grouting will be paid for per barrel of cement used. As a fair provision for such contingencies, it is assumed, except in cases otherwise specially provided for herein, that the excavation and therefore the concrete and rock packing will extend outside the neat lines to an average line designated Standard Section Line on the Contract Drawings and it is understood that the prices for excavation, concrete and rock packing outside neat lines per lineal foot of tunnels in the schedule are based on measurement of same as defined by the standard section lines previously referred to. No allowance will be made to the Contractor for excavation removed and replaced by concrete or rock packing outside of the standard section line, nor will any deduction be made from either by reason of any material he may not excavate between neat and standard section lines. Where an increased thickness in masonry lining is required by the Engineer, as above provided, a corresponding displacement of the standard section line will be understood and payment will be made for the increase in the standard section at the prices named in the Schedule of Unit Prices for excavation, masonry, concrete, or rock packing. The standard section lines above referred to will extend to beyond the neat lines of various tunnel sections as follows:

281. In concrete lined tunnels and tunnels with brick arches with and without rock packing the standard section lines will extend an average distance of one foot outside the neat lines on the roof and sides and six inches outside the neat lines in the floor or invert, as per Contract Drawings Nos. 1028, 1029, 1033, 1034, 1036, 1037, 1049, 1050, 1051, 1059.

282. Timbering shall be used wherever necessary to support the materials or to secure the safety of the work or workmen. This will be at the sole expense of the Contractor and included in his contract price, except in cases where by the direction of the Engineer the timber is built into the work.

283. The centering for arched roofs shall be of steel construction and of design approved by the Engineer, and it shall remain in place as long as he may from time to time require.

284. The Contractor shall provide to the approval of the Engineer, electric lighting for all parts of the work and plant, including lights for the Resident Engineers' offices near the shaft and portal and such special lights or groups of lights as the Engineer may require in connection with surveys. Telephone communication shall be established between the tunnels and the offices of the Resident Engineers. The Contractor shall install and operate plant for the purpose of efficiently ventilating the tunnels during construction.

Full masonry clear of timbering.

Standard Section Line—definition of.

No allowance outside of standard section lines.

If thickness of masonry is increased.

Concrete and brick arched tunnels—standard section lines.

Timbering.

Timber built in.

Centers for arches.

Lighting.

Telephones.

Ventilation.

TUNNELS DRIVEN WITHOUT SHIELDS—(*continued.*)

Drain pipes.

285. Drain pipes of 4 inches inside diameter shall be built into the concrete at intervals of not more than 50 feet on each side of the arch and alternated as shown on Contract Drawings. They shall discharge into the sub-floor drains and where shown into the cast iron drain inspection hand-holes built into the sub-floor drains. Tee branches opening against the rock face in recesses left in the concrete shall be inserted wherever necessary to drain water bearing fissures. Where the rock carries much water the distance between drains will be reduced as much as necessary to give perfect drainage and to relieve the masonry lining from water pressure.

Advance headings under Bergen Hill.

Contractor for Section Gj to use Bergen Hill tunnel for disposal of spoil.

286. The Contractor for Section K (the Bergen Hill tunnels) shall commence immediately a through heading 10 feet by 8 feet in cross section in each of the tunnels and drive them through with all possible speed from both ends. As soon as the headings are driven through, one of them shall be cleaned out and turned over to the Contractor for Section Gj for use as specified in paragraphs 214 and 306. While one is being used for this purpose the other tunnel shall be completed with its internal lining of concrete and brick and all benches, conduits, drains, etc., and cleaned out; after which the Contractor for Section Gj will vacate the first heading and use the completed tunnel for the disposal of spoil, while the Contractor for Section K finishes the vacated tunnel. The Contractor for Section Gj will keep the heading and tunnel through which he passes his spoil free from spoil that may be dropped therein.

Tunnel by cut and cover.

287. In the construction of the tunnels in the west face of Bergen Hill and adjoining portals the Contractor, should he consider it to his advantage, may construct such lengths of the tunnels by cut and cover work, subject to the approval of the Engineer; this cut and cover work will be paid for at the rates quoted in the Schedule for Bergen Hill tunnels irrespective of methods of construction.

Weehawken tunnel from Weehawken Shaft.

288. As soon as the two-thirds' portion of the Weehawken Shaft at grade level is handed over to the Contractor for Section Gj, he shall commence the driving of tunnels eastward from shaft for distances of about 214 and 250 feet, or less distances if the rock proves too unsound to permit driving tunnels without compressed air. They shall terminate in enlarged sections (shield chambers) to permit the erection of shields, as shown on Contract Drawings Nos. 1028, 1029, 1030, 1031, 1032.

CAST IRON LINED TUNNELS DRIVEN WITHOUT SHIELDS.

289. Cast iron tunnel lining shall be provided in tunnels driven without shields in places where the Engineer may consider it necessary, see Contract Drawing No. 1005.

CAST IRON LINED TUNNELS DRIVEN WITHOUT SHIELDS—(*continued.*)

290. Excavation in excess of that required to place the tunnel lining must be avoided as far as practicable, but in rock all loose or shattered rock must be removed. Where the excavation is in earth or other materials, the excavation must be large enough to permit placing the cast iron lining clear of such timbering as it may be necessary to build in. As a fair provision for unavoidable excavation outside of the lining, payment will be made for the removal of all material within the "Standard Section Line." This line is 9 inches outside of the exterior surface of the cast iron lining. No payment will be made for excavation outside of this line nor deduction for materials left within it, provided no material is left in place which will interfere with placing the cast iron lining.

291. Timbering shall be used wherever necessary to support the materials or to secure the safety of the work or workmen. Wherever practicable, it shall be removed before the space between the exterior surface of the tunnel lining and the sides of the excavation is filled in.

292. The space between the tunnel lining and the excavated surface shall be closely packed with concrete. Pipes for grouting shall be inserted in the cast iron lining and concrete wherever the Engineer may require and voids filled by grouting. The volume of concrete will be calculated between cast iron lining and standard section line, no allowance being made for concrete required to fill spaces outside of the standard section line, or deduction from either excavation or concrete on account of any materials not excavated within said line. Plugs in the tunnel lining and grout will be paid for as provided in paragraph 265.

PORTALS.

293. The portals in Weehawken Shaft and the portals on the west face of Bergen Hill shall be built of first-class stone masonry with granite face stone and coping, as shown on Contract Drawings Nos. 1050 and 1058.

294. The measurement of excavation and all materials for the portals and the approach on west side of Bergen Hill is determined from net dimensions shown on the Contract Drawings Nos. 1027, 1058, 1059, 1060.

OPEN APPROACH AT HACKENSACK PORTAL.

295. The approach to the tunnel portal on the west side of Bergen Hill is to be formed in every respect according to Contract Drawings Nos. 1027, 1058, 1059, 1060. The rock where it occurs shall be neatly

OPEN APPROACH AT HACKENSACK PORTAL—(*continued.*)

trimmed and the earth cuts neatly graded to the required slope. For measurement of excavation and material see paragraph 294.

WATERPROOFING.

- Cast iron tunnels. 296. In tunnels driven with shields, the cast iron shells will serve as waterproofing.
- Tunnels driven without shields. 297. In tunnels driven in the ordinary manner without shields, the space between the sides of the excavation and the neat line shall be filled with concrete behind suitable forms. After the forms are removed the surface of the concrete shall be given a 1/2 inch coat of mortar containing equal parts, by volume, of Portland cement and sand and troweled smooth. After the mortar has set and dried out, it shall be covered with alternate layers of coal-tar pitch and felt, seven layers of pitch and six of felt. The felt shall be "hydrex" felt manufactured by F. W. Bird & Son of East Walpole, Mass., or felt equally satisfactory to the Engineer. The pitch shall be straight run coal tar pitch which will soften at 60 deg. F., and melt at 100 deg. F., being a grade in which distillate oils, distilled therefrom, shall have a specific gravity of 1.105. The pitch shall be mopped on the surface of the concrete to a uniform thickness of not less than 1/16 inch. Immediately on this coat of pitch and while it is still melted, there shall be laid a covering of felt previously mopped with pitch on the surface to be applied, the sheets to lap not less than 4 inches on cross joints nor less than 12 inches on longitudinal joints, and to be made to adhere firmly to the pitch-covered surface of the concrete everywhere. This felt layer shall be mopped with pitch as above specified, another layer of felt mopped with pitch and then added and the process continued to the full number of layers required. This waterproofing shall extend from the level of the bottom of the electric ducts to 15 degrees above the spring line of the roof arch. After the waterproofing has been placed the remainder of the concrete with the electric ducts, etc., shall be placed.
- Waterproofing sides.
- Waterproofing materials.
- Brick roofs of tunnels driven without shields. 298. Where roofs of tunnels driven in the ordinary manner without shields are of brick, they shall be plastered with a mastic containing coal tar and Portland cement in such proportions as the Engineer may from time to time require. This shall be applied with a trowel in a uniform layer 1/2 inch in thickness. This waterproof coating shall then be covered with one course of brick laid on flat in a bed of mortar 1/2 inch thick, containing equal parts by volume of Portland cement and sand, and the joints completely filled with mortar of the same composition. The junction between the waterproofing in the roofs and sides shall be formed so as to make a continuous waterproofing surface.

WATERPROOFING—(*continued.*)

299. Where the roofs of tunnels are of concrete built solidly against the rock, the waterproofing of the roof shall consist of grout injected through pipes built into the concrete at such intervals as the Engineer may require. Roofs of tunnels built of concrete.

300. Where tunnels are built by the cut and cover method, the sides, if in rock excavation, shall be waterproofed as described in paragraph 297; if in earth excavation, they shall be waterproofed as herein specified for roof. The roofs of tunnels shall be plastered smooth and covered with coal tar and felt as specified for sides of tunnels in paragraph 297. The waterproofing shall be covered with a 1 inch layer of mortar, containing equal parts, by volume, of Portland cement and sand. The mortar shall be laid on in areas about 5 feet square and when one square is set, the adjacent ones shall be laid tight to it, this laying out in squares being for the purpose of relieving expansion or contraction. A thorough connection shall be made between the waterproofing of the top and sides. Tunnels built by cut and cover method.
Tunnel roofs.

301. The waterproofing of retaining walls and portals shall extend from the base of the wall to within one foot of the top. Where the walls are built against the face of rock excavation, the waterproofing shall conform to the requirements for sides of tunnels in paragraph 297; where the wall is not built against a rock face, the waterproofing shall be the same as specified for tunnel roofs in paragraph 300. Retaining walls and portals.

302. No waterproofing will be used in the floors except where specially required by the Engineer, and will then be paid for at the rates named in the Schedules of Unit Prices. Floors in tunnels.

303. Waterproofing and the protecting mortar coat must be protected from injury by working or walking thereon, or during the filling of rock packing over tunnel roofs, or while placing back filling behind retaining walls. Protection of waterproofing.

DISPOSAL OF MATERIALS TO BE WASTED.

304. The materials to be wasted from the Weehawken Shaft and all materials wasted from the tunnels and hoisted from this shaft previous to the completion of the first heading through Bergen Hill shall be delivered on scows, barges, cars or cars on floats furnished by the Company and placed within 1500 feet of the shaft. From Weehawken Shaft and tunnels.

305. The materials in Section K to be wasted from the small headings driven under Bergen Hill from the west end shall be delivered by the Contractor in the Company's railroad embankment adjoining the work as directed or into cars supplied by the Company at a point not more than 1000 feet west of Station 327 which is about 300 feet west of the portal on the west side of Bergen Hill. From west end of Bergen Hill headings.

DISPOSAL OF MATERIALS TO BE WASTED—(*continued.*)

From Section K
and Section Gj.

306. After the completion of the first heading under Bergen Hill all materials to be wasted from the headings of Section Gj and all materials to be wasted from Section K shall be delivered by the Contractor, as described in preceding paragraph and subject also to the provisions of paragraphs 214 and 286. The Contractor for Section K shall grade the approach cut in his contract to its full width to permit his temporary tracks and those of Contractor for Section Gj to be laid for the above mentioned purpose.

Company may require
Contractor to dispose
of all materials.

307. The Company may, however, require the Contractor on 10 days' notice to provide for the complete disposal of materials to be wasted and payment will be made therefor at the rate named in paragraph 22h of the contract.

Deposit of spoil on
work forbidden.

308. No spoil or other wasted material shall be deposited in the tunnels, shafts or elsewhere on the Company's property without the special permission of the Engineer.

MISCELLANEOUS.

Right of Engineer to
enter work.

309. The Engineer and his representatives or any other duly authorized representative of the Company shall at all times have the right to enter the premises where any of the materials are being prepared, any of the plant operated, or any of the work done.

Admission to works.

310. No person shall be admitted to the works without the written consent of the Engineer, except the Contractor and his employees, the Engineer and his representatives and duly authorized representatives of the Company and representatives of the City government in the performance of their duties.

No information con-
cerning work to be
given.

311. No information relative to the work shall be given by the Contractor or any of his employees to any person during the progress of the work unless authorized by the Engineer.

Facilities for inspec-
tion.

312. The Contractor shall furnish to the Engineer every facility for the inspection of materials and workmanship and no part of the work shall be covered until inspected by the Engineer or his representative.

Defective materials to
be removed.

313. The Contractor shall change, repair or remove and replace any material or work not in accordance with the plans or specifications whether previously accepted or not.

Rejected materials to
be removed.

314. Rejected materials shall be branded or otherwise marked and shall be removed from the works immediately and not returned.

MISCELLANEOUS—(*continued.*)

315. No concrete or other masonry shall be laid when it will be subjected to freezing before setting except with permission of the Engineer and under such conditions as he may impose in writing.

Masonry in freezing weather.

316. Excavation will include rock, earth, boulders, piles, timber and all other materials met. It shall be understood that excavation is not classified for the purpose of estimates or payments under either of the contracts.

Definition of excavation.

317. Excavation shall be measured in the solid in place, with no allowance for increase in volume after excavation. No payment will be made for excavation or concrete outside Standard Section Lines, shown on plans or described in these specifications.

Excavation—measurement of.

Standard Section Lines.

318. Where quantities per lineal foot of tunnel are stated in the contract schedules, they are average quantities, manholes, recesses, grooves, troughs, cross passages between tunnels, cast steel bore segments and all other special constructions, except those separately scheduled in the contract, being divided over the entire length of the sections and embraced in the respective schedules. The length of tunnel to be paid for under each schedule will be determined by measurement of the completed work.

Quantities scheduled are average quantities.

Lengths to be measured.

319. In cases where the method of measurement is not specifically stated elsewhere in these specifications, measurements will be made from the draft lines and dimensions shown on the Contract Drawings or other plans furnished by the Engineer, notwithstanding any custom to the contrary. All openings and imbedded materials will be deducted.

Measurements from plans where not otherwise specified.

320. All water pumped or bailed from the tunnels, shafts or trenches during construction shall be conveyed to suitable points of discharge and in pipes buried in the ground if required.

Disposal of drainage water.

321. The Contractor shall employ a sufficient number of watchmen to guard all parts of the work and no heading shall be left without a competent watchman.

Watching.

322. The Contractor shall maintain every part of the work in thoroughly good condition (ventilating and pumping when necessary) until finally accepted by the Engineer.

Maintenance of work during construction.
Pumping.

323. The Company will maintain the work in first class manner at the cost of the Contractor against all defects of workmanship or material furnished by the Contractor for a period of 12 months after the opening of the tunnel for customary railroad traffic. Such maintenance charge shall not, however, include damage arising from derailment, collisions or fires during the operation of the railroad.

Maintenance of work after completion.

MISCELLANEOUS—(continued.)

Engineer to order discharge of unsatisfactory employees of Contractor.

324. The Engineer may order the discharge of any employee of the Contractor for inefficiency or for conduct which in the opinion of the Engineer is prejudicial to the interests of the Company, and such order shall be obeyed immediately by the Contractor and the employee shall not be again employed on the work. Sub-Contractors and their employees shall be considered as employees of the Contractor.

Junctions between types of works.

325. The work of construction includes all the work of joining up various types or sections of tunnels and in every respect forming complete and watertight tunnels throughout to the satisfaction of the Engineer.

Care in blasting.

326. Drilling and blasting must be conducted with all possible care and in such a manner as to loosen as little rock outside the section lines as possible.

Explosives, handling, storing, etc.

327. Only experienced men shall be allowed to handle explosives, and all city and other government regulations regarding their composition, storage and use must be strictly complied with.

Contractor to keep surface drainage from openings and guard same.

328. The Contractor shall protect all openings from influx of surface water from any source; he shall guard them at all times, day and night, maintain efficient lighting and be responsible for any damages or injuries to persons and property resulting from such openings.

Contractor responsible for injury to persons or property.

329. The Contractor admits and covenants to and with the Company that the plans and specifications and other provisions of the Contract for construction, if the work be done without fault or negligence on the part of the Contractor, do not involve any damage to the foundations, walls or other parts of adjacent buildings or structures, or to any street, or to the navigation of the North River, and the Contractor will, at his own expense, make good any damage which shall in the course of construction be done to any foundations, walls or other parts of adjacent buildings or structures or to any street or to navigation. The liability of the Contractor in respect to these matters is absolute and is not dependent upon any question of negligence on his part or on the part of his agents, servants or employees, and the neglect of the Engineer to direct the Contractor to take any particular precautions or to refrain from doing any particular thing shall not excuse the Contractor in case of any such damage. He shall provide support for water pipes and sewers and maintain the flow therein and admit to the works the duly authorized representatives of the City government having such pipes and sewers in charge and obey their instructions relative thereto. In case of leakage from gas pipes he shall notify the agents of the Gas Company, shall furnish laborers to get access to the pipes if requested by such agents, and adjust any claims by such company for injury to its property. He shall repair, to the satisfaction of the com-

MISCELLANEOUS—(continued.)

panies interested, all injuries to electric conduits and wires. He shall take precautions to avoid injuring sidewalks, curbs, manholes and pavements, and shall make such repairs to the same as the City government may require. He shall maintain in alignment and level the railroad tracks and structures above or contiguous to his work and support the tracks when necessary so that traffic over them may be continuously maintained.

To support railroad tracks.

330. Timber and piles left in the tunnels or in the trenches by order of the Engineer will be paid for at the actual cost of the timber and piles delivered at the site; no allowance will be made for labor of placing in the work. All timber and piles not left in by order of the Engineer will be at the sole cost and expense of the Contractor, but deductions shall be made at schedule rates for any material such as concrete, rock packing, etc., displaced by timber, whether such timber is left in by order of the Engineer or not.

Timber and piles left in work by order of Engineer to be paid for.

Concrete displaced by timber.

331. The Contractor shall protect the Company from suits for damages which may arise from injury sustained by any employee of the Contractor in the execution of the work; and from suits for loss or damages to the person or property of individuals arising from the execution of the work.

Contractor to assume liabilities in damage suits.

332. The Contractor shall obtain all licenses and permits necessary in the prosecution of his work; he shall observe all laws, franchises and ordinances relating thereto, and shall protect the Company and its employees from any penalties incurred in consequence of violation or neglect thereof by himself or any of his employees.

Contractor to obtain permits and observe ordinances.

333. The salaries and expenses of all City and other inspectors required by the governments of the borough, city, county and state in which the work is being done and the salaries and expenses of any policeman or other officers for preserving order whom the magistrates or other public authority may appoint or the Engineer consider necessary, shall be paid by the Contractor and be at his sole cost and expense.

Salaries of City inspectors and police.

Police.

334. The Contractor shall provide an adequate plant and if at any time the Engineer shall deem the plant inadequate or its operation faulty, either for the execution of the work or for the security of persons or property, he may order the same changed or discontinued and the Contractor shall comply immediately.

Engineer may order plant changed or discontinued.

335. The Contractor shall enclose all lands handed over to him by tight, substantial fences, at least 8 feet high, subject to the approval of the Engineer and the regulations and requirements of the local governments.

Fences.

336. No advertisement will be permitted on any fence enclosing any of the Company's lands or on any structure or in any place upon them.

Advertisements prohibited.

MISCELLANEOUS *-(continued.)*

Transfer of lines and levels.

337. In order to facilitate the transfer of lines and elevations, the Contractor shall suspend hoisting and working at such times and for such periods as the Engineer may deem necessary without charge to the Company.

Labor for placing monuments.

338. The Contractor shall furnish all labor and tools called for by the Engineer for placing monuments, plugs, stakes or other points used in surveys for which he will be paid actual cost of labor plus an allowance of 10 per cent. for superintendence and use of tools. If any such point be disturbed, the Engineer may require the Contractor to bear the expense of replacing it.

Work to be built on lines and levels given by the Engineer.

339. The Contractor shall build the work on the lines and levels given by the Engineer.

Only materials in permanent work paid for.

340. No payment will be made for materials which do not enter into the permanent work.

Extra work.

341. Any work which the Engineer may require in addition to that shown by the plans and standard sections or in modification thereof shall be immediately performed by the Contractor. Payment will be made for any increase of quantities and deductions made for any decrease thereof at the rates named in the Schedules of Unit Prices when the classes of work required are named in the schedules. For work not named in the schedules, payment will be made on the basis of net cost of labor and materials duly ascertained, determined and certified by the Engineer, and in addition thereto 10 per cent. of said net cost for the use of tools and all other plant, superintendence and all other miscellaneous expenses; or in lieu of such payment for net cost plus 10 per cent., the Engineer and Contractor may agree in writing upon a fixed amount to be paid by the Company for such work.

Force account.

Extra work.

342. The Contractor shall not be entitled to payment for extra work unless executed on the written order of the Engineer specifying the work to be done and the prices therefor.

Extension of time.

343. If the work is delayed by legal regulation or proceeding beyond the Contractor's control or by failure of the Company to give possession of land needed for shafts and power houses, the Contractor shall be entitled to no damage from the Company in consequence thereof, but a fair and reasonable extension of time will be allowed for the completion of the contract. If the work be interrupted by litigation, the Contractor shall have claim only for the materials and work actually furnished previous to the interruption.

Claim for extension of time.

344. Any claim by the Contractor for an extension of time shall be made in writing to the Engineer within 24 hours after the delay shall have commenced and no claim will be considered when such written notice has not been given.

MISCELLANEOUS—(*continued.*)

345. The Contractor will not be entitled to an extension of time for causes within his control, for non-delivery of plant or materials, for accidents occurring in the prosecution of the work, for weather, flood or fires, or for sickness or legal proceedings involving the Contractor. No extension of time.

346. All geological specimens desired by the Engineer and all coins and articles of antiquity found in the excavations shall be delivered to him immediately. Coins and antiques.

347. The Contractor shall afford such facilities as the Engineer may require to other Contractors or persons whom the Company may employ in connection with the work; and shall make no charge on account of such work for compressed air or for use of the compressors, boilers, and other plant when their continuous operation is required for his own work, but on the approval of the Engineer he may make a reasonable charge for hoisting materials in or out of the shafts and hauling them in the tunnels. Facilities to other Contractors and the Company's employees.

348. Upon the completion of any part of the work, the Contractor shall, on demand of the Engineer, remove his plant and materials or such portion as the Engineer may deem necessary so as not to impede the execution of the remaining works by himself or others. Upon the completion of the entire work and its acceptance by the Engineer, the Contractor shall remove from the Company's property all plant and materials of every description belonging to him and leave the premises free from rubbish and waste materials and in a finished condition. Removal of plant and materials.
Clean up works.

349. The properties of the Erie Railroad Company and the New Jersey Junction Railroad over or adjoining the various works must at all times be efficiently protected from any possible or probable injury during construction and any further measures necessary to carry this out shall be done in compliance with the order of the Engineer. Protect other railroad companies' properties.

350. The centre line of the railroad tunnel works of this Division is located very nearly on a southeasterly to northwesterly line, but it shall be understood for convenience in this contract and during the construction, as being located on a line from East to West. On the Contract Drawings the initials "N," "E," "S" and "W" are placed with the intention of giving the lay of plans and sections as indicated thereon. Lay of centre line of tunnel works.

CONTRACT

CONTRACT.

AGREEMENT made this.....day of.....1903,
between the PENNSYLVANIA, NEW JERSEY & NEW YORK RAILROAD COMPANY,
hereinafter called the Company, party of the first part, and.....
.....
of.....
hereinafter called the Contractor, party of the second part,—WITNESSETH:

1. That the Contractor, the said party of the second part, in consideration of the agreement herein, by the Company, the said party of the first part, does hereby promise and agree to and with the said party of the first part, that he will at his own sole cost and expense furnish all labor and services and all material for, and will construct, complete and finish in the most thorough, workmanlike and substantial manner, in every respect to the satisfaction and approval of the Company's Chief Engineer or Engineers for the time being (hereinafter referred to as the Engineer) in the manner and within the time hereinafter limited, subject to the terms, restrictions and conditions of the Company's franchise and according to the specifications hereto annexed and made part of this contract and in strict accordance with plans furnished or to be furnished by the Engineer therefor, the tunnels and approaches commencing at the boundary line of the States of New Jersey and New York in the North River, passing under same and under Bergen Hill in the State of New Jersey together with the approach to the tunnels for a distance of three hundred (300) feet westward from the portals of the tunnels in the west face of Bergen Hill, as the same are now or may be hereafter located and that he will pay to the Company the costs of maintaining the same in good and perfect condition, without interfering with traffic through any portion thereof, to the full satisfaction of the Engineer, for a period of twelve (12) months after the completion of the work shall have been certified by the said Engineer.

2. The plans and specifications of this contract are intended to co-operate, so that any work exhibited in the plans and not mentioned in the specifications, or *vice versa*, shall be done in the same manner as if mentioned in the specifications and set forth in the plans, to the true intent and meaning of said plans and specifications or either of them. The Contractor, at his own proper cost and charges, shall provide all manner of labor, materials, apparatus, scaffolding, tools and machinery of every description required to do and complete the work.

3. Said work shall be commenced as soon as the site of shaft is handed over to the Contractor, who shall remove all obstructions required by the Engineer and shall thenceforth prosecute the work continuously and diligently. The whole of the work embraced in this contract shall be completed withinmonths after the site of shaft has been handed over to him.

4. The plans herein referred to are fifty-eight (58) in number, bear date August 1st, 1903, are each signed by the Engineer, bear the general title of "Contract Drawing No.," and are designated by the following numbers:—1000, 1001, 1002, 1003, 1004, 1005, 1006, 1007, 1008, 1009, 1010, 1011, 1012, 1013, 1014, 1015, 1016, 1017, 1018, 1019, 1023, 1024, 1025, 1026, 1027, 1028, 1029, 1030, 1031, 1032, 1033, 1034, 1035, 1036, 1037, 1038, 1039, 1040, 1041, 1042, 1043, 1044, 1045, 1046, 1047, 1048, 1049, 1050, 1051, 1052, 1053, 1054, 1055, 1056, 1057, 1058, 1059, 1060.

5. The sections and dimensions of all parts shown on the Contract Drawings are typical sections and dimensions applicable to the greater part of the work. Where extraordinary conditions exist, or unforeseen contingencies arise, or if for any other reason the Company desires to make any alterations of, deviations from, additions to or omissions from the work to be done under this contract or plans or specifications attached hereto, then the Company may issue special plans, duly signed by the Engineer and accompanied by specifications explanatory thereof or describing the method of construction, changing the sections or the dimensions of the part or the materials of the structure, and such special plans and specifications when so issued shall be binding on the Contractor and he shall receive no additional payment for the completed work unless the quantities of materials therein, or excavation therefor, are greater than in the typical sections and dimensions. The amount of additional payment, if any, shall be only for the increase of quantities and shall be paid for at the rates named in the schedule herein agreed upon. If the completed work built under the changed plans contains less quantities of materials or requires less amounts of excavation than the typical sections and dimensions, the payment to the Contractor shall be reduced by an amount to be determined in the same manner. If in any case work is required to be done or materials furnished for which unit prices are not named in the schedules, then payment shall be made for the net cost of such labor and materials, duly ascertained, determined and certified by the Engineer and in addition thereto ten per cent. of said net cost for the use of tools and all other expenses; or in lieu of such payment for net cost plus ten per cent. the Engineer and Contractor may agree in writing upon a fixed amount to be paid by the Company for such labor and materials.

6. In addition to the Contract Drawings, the Company has had prepared a set of drawings, five (5) in number, signed by the Engineer, and bearing the

same date as the Contract Drawings, but entitled "Supplementary Drawing No.," and are designated by the following numbers:—S. 1000, S. 1001, S. 1002, S. 1003, S. 1004. These drawings exhibit certain data which the Company has obtained from its Engineer concerning the nature of the soil underlying portions of the route. The Supplementary Drawings have been exhibited to the Contractor without any guaranty on the part of the Company as to their completeness and correctness; and the Contractor may, at his option and at the expense of the Company have copies thereof for such aid, if any, as the Contractor may derive from them. If in the course of the work embraced in this contract, difficulties of any nature be encountered which are not indicated or suggested by the Supplementary Drawings or if additional surface or sub-surface structures or obstructions be discovered or found of different size or in different positions or of different nature from those shown on the Supplementary Drawings, or if in any way such Supplementary Drawings be found erroneous, the Contractor shall have no claim whatever for any such failure, discrepancy or error, but is to take every necessary or proper precaution to overcome the unforeseen difficulty and is to take care of, protect, remove, adjust, or readjust, as the case may be, the additional or different surface or sub-surface structures according to the directions of the Engineer. The Contractor agrees to obtain any further information in regard to the geological formation which he may deem necessary or desirable at his own cost and expense, providing himself with any and all permits, licenses and other consent and privilege required by City or other government authorities.

7. The Company has made tests with a screw pile at Dock C, Erie Railroad, Weehawken, and the Engineer has kept a record of the process of sinking, power used and other data. Tables showing these results and drawings showing the appliances used may be seen at the office of the Engineer, but the Company does not in any way guarantee that like results will be obtained at other points, and if in the progress of the work difficulties are found differing in nature or extent from those shown by the record aforesaid, or if different appliances for sinking the screw piles in the tunnels are found necessary or expedient the Contractor shall have no claim whatever for such difficulties or appliances but is to take every means necessary to perform the work as shown on the Contract Drawings and required by the specifications.

8. The Contractor shall be entitled to no payment for extra work or materials excepting as provided in the specifications and in this contract and under a written order of the Engineer and then only when a claim therefor is presented to the Engineer for allowance at the close of the calendar month in which the same had been done or furnished; otherwise, all claims for such work or materials shall be deemed absolutely waived by the Con-

tractor and the Company shall not be required to allow or pay for the same or for any part thereof.

9. In order to prevent disputes and misunderstandings between the parties hereto in relation to the performance of any of the stipulations and provisions contained in this agreement, or as to the true intent and meaning hereof, or as to any other question which may arise hereunder and for the speedy settlement of any such disputes and misunderstandings as may arise hereunder, it is hereby agreed that the Engineer shall be and he hereby is constituted the sole umpire to finally decide all such questions and matters and to settle any such disputes and misunderstandings as aforesaid; and said Engineer shall also decide the amount and quality, character and kind of work and material performed and furnished by the Contractor under this contract, including all extra work and material and claims for compensation therefor.

10. The Company contemplates, and the Contractor hereby approves, the most thorough and minute inspection by the Company, its Engineer and the representatives and subordinates of the Company or Engineer, of all work and materials and of the manufacture or preparation of such materials from the beginning of construction to the final completion of the work and to the expiration of the subsequent term during which by the terms of this contract, the Contractor is to pay the cost of maintaining the work in good and perfect condition. It is the intention of the Company that the Engineer shall draw the attention of the Contractor to all errors and variations from the requirements of the contract and specifications, or other defects in workmanship or materials, but it is expressly agreed that no omission on the part of the Company or its Engineer or any officer, representative, or subordinate of the Company shall give the Contractor any right or claim against the Company or in any way relieve the Contractor from his obligation to fully construct the work according to the terms of this contract.

11. The Contractor shall at all times give to the Engineer and the assistants and representatives under the Engineer, all facilities, either necessary or convenient, for inspecting the materials to be furnished and the work to be done under this contract. The Engineer or any person bearing his authorization or the authorization of the Company shall be admitted at any time summarily and without delay to any part of the work, or to an inspection of materials at any place or stage of their manufacture, preparation, shipment or delivery.

12. The Contractor shall give ample notice to the Engineer of the beginning or progress of manufacture or preparation of materials at mills, shops, foundries or other points so that the Engineer's representatives may be on hand.

13. All work to be done hereunder shall be at all times under the supervision of the Engineer or representatives appointed by him and the instruc-

tions of the Engineer or such representatives shall at all times be implicitly obeyed; and the Engineer shall decide as to the materials supplied and work done under this contract.

14. The Contractor agrees to receive from the Company, and the Company to deliver to the Contractor all cement required in the permanent work at the rate of two dollars (\$2.00) for 380 pounds of cement, the cement to be delivered to the Contractor in warehouses selected and rented or owned by the Company and the location of these shall be for the Contractor for Section Gj (Subaqueous tunnels, etc.,) on the west water front of North River and not more than 1000 feet from the centre line of tunnels and for the Contractor for Section K (Bergen Hill Tunnels) not more than 600 feet west of tunnel portal on the west side of Bergen Hill. At the end of each month, the Engineer shall furnish the Contractor a statement of the amount of cement thus delivered to the Contractor during the month, and is hereby authorized to deduct the amount due therefor from the next or any following estimate. The cement is to be delivered in sacks which will become the property of the Contractor. The Contractor is to be responsible for the safe-keeping of the cement after delivery to him. The Company will diligently endeavor to keep on hand at all times a sufficient supply of cement but the Contractor shall have no claim for damages if at any time or times the supply shall be insufficient and the work impeded or delayed thereby; but he shall be entitled to an extension of time for the completion of his contract by a period equal to that during which the work was so impeded or delayed, the same as hereinafter provided in case the work is impeded or delayed by the order of any court.

15. It is further agreed between the parties hereto that the Contractor shall have no right or power to assign this contract in whole or in part, nor to assign any right arising thereunder.

16. It is further agreed that no part of the work embraced in this contract shall be sublet or in any way removed from the control of the Contractor under the direction and supervision of the Engineer as aforesaid, except with the written consent of the Engineer, but this provision shall not apply to the purchase and delivery of materials necessarily manufactured and provided elsewhere.

17. The Company in consideration of the faithful performance by the Contractor of all and singular his covenants, promises and agreements herein contained, agrees to pay the said Contractor, on the full completion by him of all things embraced in this contract, in the manner and within the time herein specified and limited, and to the satisfaction and acceptance of the said Engineer, at the rates named in the following Schedules:

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.

NORTH RIVER TUNNELS—CAST IRON LINED.

DRIVEN WITH SHIELD.

From at or near Station 231 + 78 to at or near Station 261 + 36.

Schedule No. 24.

For materials in ONE LINEAL FOOT of completed work as shown on Contract Drawings Nos. 1000, 1002, 1003, 1004, 1006, 1007, 1008, 1009, 1010, 1011, 1014, and 1018, including all labor required thereon. Excavation measured as described in paragraphs 277 and 317 of the specifications. The quantities of materials in this schedule are average quantities for 5880 lineal feet of tunnel.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Excavation.....	15.39 cu. yds..	.....	.....	.....	.....
Cast iron tunnel lining.....	8,842.66 lbs.....	.....	.....	.....	.....
Cast steel tunnel lining (bore segments and manhole segments).....	299.35 “ .....	.....	.....	.....	.....
Steel bolts and washers for tunnel lining.....	329.00 “ .....	.....	.....	.....	.....
Rust joints caulked in tunnel lining.....	38.60 lin. ft....	.....	.....	.....	.....
Cast iron drain pipes.....	7.31 lbs.....	.....	.....	.....	.....
Cast iron fillers caulked and steel dowels in bore segments .....	..... the sum of .....	.....	.....	.....	.....
Iron castings (exclusive of tunnel linings and screw pile shafts).....	4.55 lbs.....	.....	.....	.....	.....
Concrete placed in air of normal pressure.....	4.96 cu. yds..	.....	.....	.....	.....
Grout, outside of tunnel lining, cement used.....	2.90 bbls.....	.....	.....	.....	.....
Steel beams, plates and shapes with fittings at manholes and electric chambers.....	20.95 lbs.....	.....	.....	.....	.....
Steel bolts, hooks, staples, ladders, ladder rods, manhole gratings and bonds for electric conduits.....	5.24 “ .....	.....	.....	.....	.....
Expanded metal.....	1.25 “ .....	.....	.....	.....	.....
Vitrified electric conduits....	52.91 duct ft...	.....	.....	.....	.....
Galvanized iron wire, No. 8, B. & S. gauge.....	55.00 lin. ft....	.....	.....	.....	.....
Total for ONE LINEAL FOOT.....		.....	.....	.....	.....

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—(continued.)

SCREW PILES—NORTH RIVER TUNNELS.

(Under 30 feet and 30 to 50 feet long.)

Schedule No. 25.

For materials in completed work in ONE SCREW PILE driven 30 feet as shown on Contract Drawings Nos. 1000, 1004, 1012, 1013, 1015 and 1019, including all labor required thereon; measured partly as described in paragraphs 259 and 260 of the specifications.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections, including special section at top.....	9,378.00 lbs.....	.....	.....	.....	.....
Steel bolts for screw pile sections.....	78.00 “ .....	.....	.....	.....	.....
Steel dowels for screw pile sections.....	93.90 “ .....	.....	.....	.....	.....
Cast steel screw pile point....	1,635.00 “ .....	.....	.....	.....	.....
Steel sleeve with collar, rust jointing, etc.....	2,460.00 “ .....	.....	.....	.....	.....
Steel diaphragm tapped and plugged.....	108.00 “ .....	.....	.....	.....	.....
Steel bolts connecting diaphragm and taper rings to screw pile.....	76.00 “ .....	.....	.....	.....	.....
Cast iron packing and taper adjustment rings.....	246.50 “ .....	.....	.....	.....	.....
Iron grouting pipe 2" diameter within screw pile	12.00 lin. ft....	.....	.....	.....	.....
Excavation within screw pile to 12 feet deep.....	1.46 cu. yds..	.....	.....	.....	.....
Concrete within screw pile....	1.46 “ “ .....	.....	.....	.....	.....
Grout within screw pile, cement used.....	1.00 bbl.....	.....	.....	.....	.....
Total for ONE SCREW PILE driven to a depth of 30 feet.....		.....	.....	.....	.....

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—SCREW PILES (under 30 feet and 30 to 50 feet long). *Schedule No. 25.—(continued.)*

For screw piles driven less than 30 feet the following will be deducted for each lineal foot:

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections	312.60 lbs.....				
Steel bolts for screw pile sections.....	2.60 “				
Steel dowels for screw pile sections.....	3.13 “				
Total deduction for each lineal foot of screw pile less than 30 feet.....					

For each additional lineal foot of screw pile driven in excess of 30 feet but not exceeding a total length of 50 feet:

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections	318.20 lbs.....				
Steel bolts for screw pile sections.....	2.67 “				
Steel dowels for screw pile sections.....	3.44 “				
Total for each additional lineal foot driven in excess of 30 feet but not exceeding 50 feet.....					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—SCREW PILES—(continued.)

SCREW PILES—NORTH RIVER TUNNELS.

(50 to 70 feet long.)

Schedule No. 26.

For materials in completed work in ONE SCREW PILE driven 50 feet as shown on Contract Drawings Nos. 1000, 1004, 1012, 1013, 1015 and 1019, including all labor required thereon; measured partly as described in paragraphs 259 and 260 of the specifications.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections, including special section at top	16,190.00 lbs. ....	.....	.....	.....	.....
Steel bolts for screw pile sections	136.50 “ .....	.....	.....	.....	.....
Steel dowels for screw pile sections.....	187.80 “ .....	.....	.....	.....	.....
Cast steel screw pile point....	1,635.00 “ .....	.....	.....	.....	.....
Steel sleeve with collar, rust jointing, etc.....	2,460.00 “ .....	.....	.....	.....	.....
Steel diaphragm tapped and plugged	108.00 “ .....	.....	.....	.....	.....
Steel bolts connecting diaphragm and taper rings to screw pile.....	76.00 “ .....	.....	.....	.....	.....
Cast iron packing and taper adjustment rings.....	246.50 “ .....	.....	.....	.....	.....
Iron grouting pipe 2" diameter within screw pile.....	12.00 lin. ft.. .....	.....	.....	.....	.....
Excavation within screw pile to 12 feet deep.....	1.46 cu. yds. ....	.....	.....	.....	.....
Concrete within screw pile...	1.46 “ “ . .....	.....	.....	.....	.....
Grout within screw pile, cement used.....	1.00 bbl.....	.....	.....	.....	.....
Total for ONE SCREW PILE driven to a depth of 50 feet.....		.....	.....	.....	.....

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—SCREW PILES—(50 to 70 feet long.) *Schedule No. 26.*—(con-
tinued.)

For each additional lineal foot of screw pile driven in excess of 50 feet but
not exceeding a total length of 70 feet:

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections..	326.20 lbs. ....	.....	.....	.....	.....
Steel bolts for screw pile sec- tions.....	2.76 “ .....	.....	.....	.....	.....
Steel dowels for screw pile sections	3.89 “ .....	.....	.....	.....	.....
Total for each additional lineal foot driven in excess of 50 feet but not exceeding 70 feet.....		.....	.....	.....	.....

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—SCREW PILES—(continued.)

SCREW PILES—NORTH RIVER TUNNELS.

(70 to 90 feet long.)

Schedule No. 27.

For materials in completed work in ONE SCREW PILE driven 70 feet as shown on Contract Drawings Nos. 1000, 1004, 1012, 1013, 1015 and 1019, including all labor required thereon; measured partly as described in paragraphs 259 and 260 of the specifications.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections, including special section at top.....	23,002.00 lbs.....	.....	.....	.....	.....
Steel bolts for screw pile sections.....	195.00 “ .....	.....	.....	.....	.....
Steel dowels for screw pile sections.....	281.70 “ .....	.....	.....	.....	.....
Cast steel screw pile point....	1,635.00 “ .....	.....	.....	.....	.....
Steel sleeve with collar, rust jointing, etc.....	2,460.00 “ .....	.....	.....	.....	.....
Steel diaphragm tapped and plugged.....	108.00 “ .....	.....	.....	.....	.....
Steel bolts connecting diaphragm and taper rings to screw pile	76.00 “ .....	.....	.....	.....	.....
Cast iron packing and taper adjustment rings.....	246.50 “ .....	.....	.....	.....	.....
Iron grouting pipe 2" diameter within screw pile.....	12.00 lin. ft... ..	.....	.....	.....	.....
Excavation within screw pile to 12 feet deep.....	1.46 cu. yds. ....	.....	.....	.....	.....
Concrete within screw pile ..	1.46 “ “ . ....	.....	.....	.....	.....
Grout within screw pile, cement used.....	1.00 bbl.....	.....	.....	.....	.....
Total for ONE SCREW PILE driven to a depth of 70 feet .....		.....	.....	.....	.....

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—SCREW PILES—(70 to 90 ft. long.) *Schedule No. 27.*—(continued.)

For each additional lineal foot of screw pile driven in excess of 70 feet but not exceeding a total length of 90 feet:

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections..	329.90 lbs.....				
Steel bolts for screw pile sections.....	2.80 “				
Steel dowels for screw pile sections.....	4.10 “				
Total for each additional lineal foot driven in excess of 70 feet but not exceeding 90 feet.....					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—SCREW PILES—(continued.)

SCREW PILES—NORTH RIVER TUNNELS.

(90 to 120 feet long.)

Schedule No. 28.

For materials in completed work in ONE SCREW PILE driven 90 feet as shown on Contract Drawings Nos. 1000, 1004, 1012, 1013, 1015 and 1019, including all labor required thereon; measured partly as described in paragraphs 259 and 260 of the specifications.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections, including special section at top	29,814.00 lbs.				
Steel bolts for screw pile sections.....	253.50 “				
Steel dowels for screw pile sections	375.60 “				
Cast steel screw pile point....	1,635.00 “				
Steel sleeve with collar, rust jointing, etc.....	2,460.00 “				
Steel diaphragm tapped and plugged	108.00 “				
Steel bolts connecting diaphragm and taper rings to screw pile.....	76.00 “				
Cast iron packing and taper adjustment rings	246.50 “				
Iron grouting pipe 2" diameter within screw pile.....	12.00 lin. ft..				
Excavation within screw pile to 12 feet deep	1.46 cu. yds.				
Concrete within screw pile...	1.46 “ “				
Grout within screw pile, cement used	1.00 bbl.....				
Total for ONE SCREW PILE driven to a depth of 90 feet...					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—SCREW PILES—(90 to 120 feet long.) *Schedule No. 28.*—(continued.)

For each additional lineal foot of screw pile driven in excess of 90 feet but not exceeding a total length of 120 feet:

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections	332.10 lbs.....				
Steel bolts for screw pile sections.....	2.79 “				
Steel dowels for screw pile sections.....	4.17 “				
Total for each additional lineal foot driven in excess of 90 feet but not exceeding 120 feet.....					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—SCREW PILES—(continued.)

SCREW PILES—NORTH RIVER TUNNELS.

(120 to 150 feet long.)

Schedule No. 29.

For materials in completed work in ONE SCREW PILE driven 120 feet as shown on Contract Drawings Nos. 1000, 1004, 1012, 1013, 1015 and 1019, including all labor required thereon; measured partly as described in paragraphs 259 and 260 of the specifications.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections, including special section at top.....	39,950.00 lbs.....				
Steel bolts for screw pile sections.....	331.50 “.....				
Steel dowels for screw pile sections.....	500.80 “.....				
Cast steel screw pile point....	1,635.00 “.....				
Steel sleeve with collar, rust jointing, etc.....	2,460.00 “.....				
Steel diaphragm tapped and plugged.....	108.00 “.....				
Steel bolts connecting diaphragm and taper rings to screw pile.....	76.00 “.....				
Cast iron packing and taper adjustment rings.....	246.50 “.....				
Iron grouting pipe 2" diameter within screw pile.....	12.00 lin. ft..				
Excavation within screw pile to 12 feet deep.....	1.46 cu. yds.				
Concrete within screw pile...	1.46 “ “				
Grout within screw pile, cement used.....	1.00 bbl.....				
Total for ONE SCREW PILE driven to a depth of 120 feet....					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—SCREW PILES—(120 to 150 feet long.) *Schedule No. 29.—(continued.)*

For each additional lineal foot of screw pile driven in excess of 120 feet but not exceeding a total length of 150 feet:

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections..	333.40 lbs.....	.....	.....	.....	.....
Steel bolts for screw pile sections.....	2.75 “ .....	.....	.....	.....	.....
Steel dowels for screw pile sections.....	4.17 “ .....	.....	.....	.....	.....
Total for each additional lineal foot driven in excess of 120 feet but not exceeding 150 feet... ..		.....	.....	.....	.....

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—SCREW PILES—(continued.)

SCREW PILES—NORTH RIVER TUNNELS.

(150 feet long and over.)

Schedule No. 30.

For materials in completed work in ONE SCREW PILE driven 150 feet, as shown on Contract Drawings Nos. 1000, 1004, 1012, 1013, 1015 and 1019, including all labor required thereon; measured partly as described in paragraphs 259 and 260 of the specifications.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections, including special section at top	50,086.00 lbs.				
Steel bolts for screw pile sections.....	409.50 “				
Steel dowels for screw pile sections.....	626.00 “				
Cast steel screw pile point....	1,635.00 “				
Steel sleeve with collar, rust jointing, etc.....	2,460.00 “				
Steel diaphragm tapped and plugged.....	108.00 “				
Steel bolts connecting diaphragm and taper rings to screw pile.....	76.00 “				
Cast iron packing and taper adjustment rings.....	246.50 “				
Iron grouting pipe 2" diameter within screw pile.....	12.00 lin. ft.. ..				
Excavation within screw pile to 12 feet deep.....	1.46 cu. yds.. ..				
Concrete within screw pile...	1.46 “ “ .				
Grout within screw pile, cement used.....	1.00 bbl.				
Total for ONE SCREW PILE driven to a depth of 150 feet					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—SCREW PILES—(150 feet long and over.) *Schedule No. 30.—(continued.)*

For each additional lineal foot of screw pile driven in excess of 150 feet:

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Cast iron screw pile sections..	333.90 lbs.....	.....	.....	.....	.....
Steel bolts for screw pile sections	2.73 “ .....	.....	.....	.....	.....
Steel dowels for screw pile sections.....	4.17 “ .....	.....	.....	.....	.....
Total for each additional lineal foot driven in excess of 150 feet.....				.....	.....

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—(continued.)

WEEHAWKEN TUNNEL ENLARGEMENTS.

(Shield Chambers.)

From at or near Station 261 + 00 to at or near Station 261 + 26.

Schedule No. 31.

For materials in ONE LINEAL FOOT of completed work in tunnel enlargement as shown on Contract Drawings Nos. 1001, 1003, 1028, 1029, 1030, 1031, 1032, 1033, 1039 and 1040, including all labor required thereon. Excavation and masonry measured as described in paragraphs 278 to 281 and 317 inclusive of the specifications. The quantities of materials in this schedule are average quantities for 52 lineal feet of tunnel.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Excavation	29.31 cu. yds...				
Cast iron drain pipes.....	96.46 lbs.....				
Iron castings.....	48.90 “				
Concrete	11.69 cu. yds. ..				
Brick masonry	1.86 “ “ ..				
Rock packing.....	2.00 “ “ ..				
Steel beams, plates and shapes with fittings at manholes and electric chambers.....	520.69 lbs.....				
Steel bolts, hooks, staples, lad- ders, ladder rods, manhole gratings and bonds for elec- tric conduits.....	18.08 “				
Expanded metal.....	6.00 “				
Vitrified electric conduits.....	50.62 duct ft. ..				
Waterproofing, felt and pitch, area covered.....	44.62 sq. ft.....				
Waterproofing, mastic and brick, area covered.....	30.38 “ “				
Flags	3.04 “ “				
Galvanized iron wire, No. 8, B. & S. gauge.....	69.23 lin. ft.....				
Total for ONE LINEAL FOOT.....					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—(continued.)

WEEHAWKEN TUNNELS.

(East of Weehawken Shaft.)

From at or near Station 261 + 26 to at or near Station 263 + 50.

Schedule No. 32.

For materials in ONE LINEAL FOOT of completed work in Concrete Tunnel with Brick Arch, as shown on Contract Drawings Nos. 1000, 1001, 1003, 1033, 1034, 1035, 1036, 1037, 1038, 1039, 1040, 1041, 1042 and 1043, including all labor required thereon. Excavation, masonry and rock packing measured as described in paragraphs 278 to 281 and 317 inclusive of the specifications. The quantities of materials in this schedule are average quantities for 412 lineal feet of tunnel.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Excavation	19.97 cu. yds.....				
Cast iron drain pipes.....	73.31 lbs.....				
Iron castings.....	9.80 “				
Concrete	6.27 cu. yds.....				
Brick masonry.....	1.70 “ “				
Rock packing.....	1.45 “ “				
Steel beams, plates and shapes with fittings at manholes and electric chambers.....	33.91 lbs.....				
Steel doors, frames and fittings	3.28 “				
Steel bolts, hooks, staples, ladders, ladder rods, man- hole gratings and bonds for electric conduits.....	14.49 “				
Steel rods and bars built into concrete.....	4.59 “				
Norway iron flat bars, 3 x 1 3/4 inches	2.18 “				
Expanded metal.....	1.97 “				
Vitrified electric conduits....	82.19 duct ft.....				
Wrought iron pipes, 3 1/2" inside diameter, of standard thickness, including bent pipes.....	0.58 lin. ft.....				
Waterproofing, felt and pitch, area covered.....	25.39 sq. ft.....				
Waterproofing, mastic and brick, area covered.....	30.99 “ “				
Flags	3.26 “ “				
Galvanized iron wire, No. 8, B & S. gauge.....	85.55 lin. ft.....				
Total for ONE LINEAL FOOT.....					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—(continued.)

NORTH RIVER TUNNELS—CAST STEEL LINED.

DRIVEN WITH SHIELD.

Schedule No. 33.

For materials in ONE LINEAL FOOT of completed work as shown on Contract Drawings Nos. 1000, 1002, 1003, 1004, 1006, 1007, 1008, 1009, 1010, 1011, 1014 and 1018, including all labor required thereon. Excavation measured as described in paragraphs 277 and 317 of the specifications.

The quantities of materials in this schedule from "Excavation" to "Rust joints" inclusive are averaged on 15 lineal feet of tunnel lining, and other quantities are assumed to be the same as for iron lined tunnels in Schedule No. 24.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Excavation	15.39 cu. yds..				
Cast steel tunnel lining, including bore segments.....	9,929.81 lbs.....				
Steel bolts and washers for tunnel lining.....	329.13 "				
Rust joints caulked in tunnel lining	38.60 lin. ft..				
Cast iron drain pipes.....	7.31 lbs.....				
Cast iron fillers caulked and steel dowels for bore segments.....	..... the sum of				
Iron castings (exclusive of tunnel linings and screw pile shafts)	4.55 lbs.....				
Concrete placed in air of normal pressure.....	4.96 cu. yds..				
Grout, outside of tunnel lining, cement used.....	2.90 bbls.....				
Steel beams, plates and shapes with fittings at manholes and electric chambers.....	20.95 lbs.....				
Steel bolts, hooks, staples, ladders, ladder rods, manhole gratings and bonds for electric conduits.....	5.24 "				
Expanded metal.....	1.25 "				
Vitrified electric conduits.....	52.91 duct ft..				
Galvanized iron wire, No. 8, B. & S. gauge.....	55.00 lin. ft...				
Total for ONE LINEAL FOOT.....					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—(continued.)

CAST IRON LINED TUNNEL DRIVEN WITHOUT SHIELD.

Schedule No. 34.

For materials in ONE LINEAL FOOT of completed work in iron and concrete lined tunnel driven without shield as shown on Contract Drawings Nos. 1000, 1002, 1003, 1005, 1007, 1008, 1009, 1010 and 1011, including all labor required thereon. Excavation and concrete measured as described in paragraphs 280, 290, 291, 292 and 317 of the specifications. The quantities of materials in this schedule from "Excavation" to "Rust joints" inclusive are averaged on a ring-length of tunnel lining, the other quantities are assumed to be the same as for iron lined tunnels in Schedule No. 24.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Excavation	17.46 cu. yds..	.....	.....	.....	.....
Cast iron tunnel lining.....	9,100.00 lbs.....	.....	.....	.....	.....
Steel bolts and washers for tunnel lining.....	330.00 " .....	.....	.....	.....	.....
Rust joints caulked in tunnel lining.....	38.80 lin. ft...	.....	.....	.....	.....
Iron castings (exclusive of tunnel lining)	4.55 lbs.....	.....	.....	.....	.....
Concrete	4.96 cu. yds..	.....	.....	.....	.....
Steel beams, plates and shapes with fittings at manholes and electric chambers.....	20.95 lbs.....	.....	.....	.....	.....
Steel bolts, hooks, staples, lad- ders, ladder rods, manhole gratings and bonds for elec- tric conduits.....	5.24 " .....	.....	.....	.....	.....
Expanded metal.....	1.25 " .....	.....	.....	.....	.....
Vitrified electric conduits	52.91 duct ft..	.....	.....	.....	.....
Galvanized iron wire, No. 8, B. & S. gauge.....	55.00 lin. ft...	.....	.....	.....	.....
Total for ONE LINEAL FOOT.....		.....	.....	.....	.....

The unit prices named in Schedules Nos. 24 to 34 inclusive are also to be used if the plans are changed as provided for in paragraph 14 of the specifications. If materials or labor not enumerated in the schedules are required to be placed in the work by direction of the Engineer and under the terms of the specifications providing for changes in the plans, payment shall be made therefor at the rates named in the following Schedule No. 35:

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—(continued.)

Schedule No. 35.

For materials in the completed work not shown on the Contract Drawings, including all labor required thereon:

	Unit.	Unit Price.	
		\$	¢
Structural steel sliding rings of tunnel lining placed in compressed air.....	lb.		
Cast iron drain pipes.....	“		
Iron castings (exclusive of tunnel lining and screw pile shafts).....	“		
Steel castings (exclusive of tunnel lining and screw pile points).....	“		
Concrete laid in compressed air.....	cu. yd.		
Brick masonry (not arch work).....	“ “		
Brick masonry, laid in compressed air.....	“ “		
Brick masonry, laid in compressed air (arch work)....	“ “		
Stone masonry.....	“ “		
Granite pedestals.....	cu. ft.		
Granitoid.....	“ “		
Grout, cement used.....	bbl.		
Grout, forced outside of tunnel lining by air pressure, cement used.....	“		
Rock packing.....	cu. yd.		
Pile shoes.....	lb.		
Structural steel, including riveted and bolted work, plates, shapes, etc.....	“		
Structural steel in sides and roofs of tunnels.....	“		
Steel doors, frames and fittings.....	“		
Steel rods and bars built into concrete.....	“		
Vitrified drain pipes, 4" in diameter.....	lin. ft.		
“ “ “ 6" “ “.....	“ “		

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION Gj.—Schedule No. 35.—(continued.)

	Unit.	Unit Price.	
		\$	¢
Vitrified drain pipes, 8" in diameter.....	lin. ft.		
" " " 10" " ".....	" "		
" " " 12" " ".....	" "		
Wrought iron pipes, 3 1/2" inside diameter, of stand- and thickness, including bent pipes.....	" "		
Waterproofing, felt and pitch, area covered.....	sq. ft.		
Waterproofing, mastic and brick, area covered.....	" "		
Waterproofing, mastic 1/2 inch thick, area covered...	" "		
Flags.....	" "		
Timber, but not including timber left in tunnels or trenches by order of the Engineer and paid for at cost delivered at the site, in accordance with para- graph 330 of the specifications:			
Yellow Pine, "Merchantable".....	M.ft. B.M.		
" " "Prime".....	" " "		
Spruce.....	" " "		
Oak.....	" " "		
Piles, but not including piles left in the work by order of the Engineer and paid for at cost delivered at the site, in accordance with paragraph 330 of the specifications:			
Yellow Pine.....	lin. ft.		
Spruce.....	" "		
Hemlock.....	" "		
Oak.....	" "		
Clay puddle.....	cu.yd.		
Asphalt, 3/4" thick.....	sq. ft.		
Cutting away any concrete built under this contract, including disposal.....	cu.yd.		
Cutting away any brick work built under this con- tract, including disposal.....	" "		
Excavation within screw pile below 12 feet from top of screw pile.....	" "		
Dressing rock to form bed for short screw piles.....	per pile		

SECTION I.

WEEHAWKEN SHAFT.

(To be temporarily used by Contractors for Sections Gj and K for constructional purposes.)

Schedule No. 36.

For materials in completed work as shown on Contract Drawings Nos. 1044 and 1045, including all labor required thereon. Excavation measured as described in paragraphs 212 and 317 of the specifications.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Excavation.....	23,800 cu. yds....	.....	.....	.....	.....
Concrete in retaining walls...	1,333 “ “ ...	.....	.....	.....	.....
Clay puddle, 12" thick, including sheet piling.....	5,600 sq. ft.....	.....	.....	.....	.....
Granitoid in coping.....	1,813 cu. ft.....	.....	.....	.....	.....
Total for Weehawken shaft.....		.....	.....	.....	.....

The unit prices named in Schedule No. 36 are also to be used if the plans are changed, as provided for in paragraph No. 14 of the specifications. If materials or labor not enumerated in the schedules are required to be placed in the work by direction of the Engineer, and under the terms of the specifications providing for changes in the plans, payment shall be made therefor at the rates named in the following Schedule No. 37:

Schedule No. 37.

For materials in the completed work not shown on the Contract Drawings, including all labor required thereon:

	Unit.	Unit Price.	
		\$	¢
Steel beams and shapes.....	lb.	.....	.....
Steel rods and bars built into concrete.....	“	.....	.....
Expanded metal.....	“	.....	.....
* Clay puddle.....	cu. yd.	.....	.....

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION K.

MISCELLANEOUS WORK IN WEEHAWKEN SHAFT.

(To be temporarily used by Contractors for Sections Gj and K for constructional purposes.)

Schedule No. 38.

For materials in completed work as shown on Contract Drawings Nos. 1001, 1046, 1047, 1048, 1049, 1050, 1051, 1052, 1053, 1054, 1055, 1056 and 1057, including all labor required thereon. Excavation measured as described in paragraphs 280, 317 and 319 of the specifications.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Excavation	1,537.00 cu. yds.	.....	.....	.....	.....
Cast iron drain pipes.....	12,519.00 lbs.....	.....	.....	.....	.....
Iron castings.....	4,282.00 “ .....	.....	.....	.....	.....
Concrete	1,701.00 cu. yds.	.....	.....	.....	.....
Brick masonry	75.70 “ “ .....	.....	.....	.....	.....
Stone masonry	259.53 “ “ .....	.....	.....	.....	.....
Rock packing	47.00 “ “ .....	.....	.....	.....	.....
Cabin over stairway complete	the sum of .....	.....	.....	.....	.....
Structural steel, including riveted and bolted work, plates, shapes, etc.....	23,011.00 lbs.....	.....	.....	.....	.....
Steel beams, plates and shapes with fittings at manholes and electric chambers.....	4,380.00 “ .....	.....	.....	.....	.....
Steel doors, frames and fittings.....	2,576.00 “ .....	.....	.....	.....	.....
Steel bolts, hooks, staples, ladders, ladder rods, manhole gratings and bonds for electric conduits.....	3,562.00 “ .....	.....	.....	.....	.....
Norway iron flat bars, 3 x 1 3/4 inches.....	900.00 “ .....	.....	.....	.....	.....
Expanded metal.....	214.00 “ .....	.....	.....	.....	.....
Carried Forward.....	.....	.....	.....	.....	.....

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION K.—(continued.)

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Brought Forward.....					
Vitrified electric conduits....	23,967.00 duct ft.				
Waterproofing, felt and pitch, area covered.....	6,528.00 sq. ft..				
Waterproofing, mastic and brick, area covered.....	913.00 “ “				
Flags	836.00 “ “				
Galvanized iron wire, No. 8, B. & S. gauge.....	24,396.00 lin. ft..				
Gutter in iron and concrete..	211.00 “ “				
Asphalt, 3/4" thick.....	444.00 sq. ft..				
Wrought iron fence.....	523.00 lin. ft..				
Iron pipe railing, 1 1/2" diam with supports.....	296.00 “ “				
Total for Miscellaneous Work in Weehawken Shaft					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION K.—(continued.)

BERGEN HILL TUNNELS.

From at or near Station 264 + 80 to at or near Station 323 + 90.

Schedule No. 39.

For materials in ONE LINEAL FOOT of completed work in concrete tunnel with brick arch, as shown on Contract Drawings Nos. 1001, 1023, 1024, 1025, 1026, 1033, 1034, 1035, 1036, 1037, 1038, 1039, 1040, 1041, 1042 and 1043, including all labor required thereon. Excavation measured as described in paragraphs 280, 281 and 317 of the specifications. The quantities of materials in this schedule are average quantities for 11,820 lineal feet of tunnel.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Excavation	19.45 cu. yds...				
Cast iron drain pipes	8.23 lbs.....				
Iron castings.....	7.13 “				
Concrete	6.09 cu. yds...				
Brick masonry	1.64 “ “				
Rock packing.....	1.42 “ “				
Steel beams, plates and shapes with fittings at manholes and electric chambers.....	16.97 lbs.....				
Steel doors, frames and fit- tings	0.91 “				
Steel bolts, hooks, staples, ladders, ladder rods, man- hole gratings and bonds for electric conduits.....	11.05 “				
Steel rods and bars built into concrete	2.40 “				
Norway iron flat bars, 3 x 1 3/4 inches.....	1.45 “				
Expanded metal	1.03 “				
Vitrified electric conduits	82.32 duct ft...				
Wrought iron pipes, 3 1/2" inside diameter, of standard thickness, including bent pipes	0.04 lin. ft...				
Waterproofing, felt and pitch, area covered	25.49 sq. ft....				
Waterproofing, mastic and brick, area covered.....	29.84 “ “				
Flags	3.27 “ “				
Galvanized iron wire, No. 8, B. & S. gauge	84.03 lin. ft...				
Total for ONE LINEAL FOOT.....					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION K.—(continued.)

HACKENSACK PORTAL AND APPROACH.

From at or near Station 323 + 90 to at or near Station 327 + 00.

Schedule No. 40.

For materials in completed work as shown on Contract Drawings Nos. 1001, 1027, 1040, 1058, 1059 and 1060, including all labor required thereon. Excavation measured as described in paragraphs 317 and 319 of the specifications.

	Quantities.	Unit Prices.		Amounts.	
		\$	¢	\$	¢
Excavation	33,662.00 cu. yds.				
Cast iron drain pipes.....	112,872.00 lbs.....				
Iron castings.....	10,448.00 “				
Concrete.....	2,809.00 cu. yds.				
Brick masonry	18.20 “ “				
Stone masonry	170.00 “ “				
Steel beams, plates and shapes with fittings at manholes and electric chambers.....	9,426.00 lbs.....				
Steel bolts, hooks, staples, lad- ders, ladder rods, manhole gratings and bonds for elec- tric conduits	3,925.00 “				
Steel rods and bars built into concrete	1,232.00 “				
Norway iron flat bars 3 x 1 3/4 inches	900.00 “				
Expanded metal.....	540.00 “				
Vitrified electric conduits	50,736.00 duct ft.				
Waterproofing, felt and pitch, area covered	24,031.00 sq. ft..				
Waterproofing, mastic and brick, area covered	84.00 “ “				
Flags	2,018.00 “ “				
Galvanized iron wire, No. 8, B. & S. gauge.....	52,080.00 lin. ft..				
Total for Hackensack Portal and Approach.....					

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION K.--(*continued.*)

The unit prices named in Schedules Nos. 38, 39 and 40 are also to be used if the plans are changed as provided for in paragraph No. 14 of the specifications. If materials or labor not enumerated in the schedules are required to be placed in the work by direction of the Engineer, and under the terms of the specifications providing for changes in the plans, payment shall be made therefor at the rates named in the following Schedule No. 41:

Schedule No. 41.

For materials in completed work not shown on the Contract Drawings, including all labor required thereon:

	Unit.	Unit Price.	
		\$	¢
Stone masonry.....	cu. yd.		
Granite pedestal.....	cu. ft.		
Granitoid.....	" "		
Grout, cement used.....	bbl.		
Grout forced in place by air pressure, cement used...	"		
Piles, but not including piles left in the work by order of the Engineer and paid for at cost delivered at the site, in accordance with paragraph 330 of the specifications:			
Yellow pine.....	lin. ft.		
Spruce	" "		
Hemlock	" "		
Oak	" "		
Pile shoes.....	lb.		
Structural steel, including riveted and bolted work, plates, shapes, etc.....	"		
Steel doors, frames and fittings.....	"		
Norway iron flat bars, 3 x 1 3/4 inches.....	"		
Vitrified drain pipes 4" in diameter.....	lin. ft.		
" " " 6" " "	" "		

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

SECTION K.—Schedule No. 41.—(continued.)

	Unit.	Unit Price.	
		\$	¢
Vitrified drain pipes 8" in diameter.....	lin. ft.		
“ “ “ 10" “ “	“ “		
“ “ “ 12" “ “	“ “		
Waterproofing, mastic 1/2 inch thick, area covered...	sq. ft.		
Timber, but not including timber left in tunnels or trenches by order of the Engineer and paid for at cost delivered at the site, in accordance with paragraph 330 of the specifications:			
Yellow pine, “Merchantable”.....	M. ft. B.M.		
“ “ “Prime”.....	“ “ “		
Spruce.....	“ “ “		
Oak.....	“ “ “		
Clay puddle.....	cu. yd.		
Asphalt, 3/4" thick.....	sq. ft.		
Cutting away any concrete built under this contract, including disposal.....	cu. yd.		
Cutting away any brick work built under this contract, including disposal.....	“ “		

18. The prices hereinbefore named are for work completed ready for track with ballast or track with bridge work where either is intended to be placed, but do not include the furnishing and placing of such track and ballast or track and bridge work.

19. It is mutually agreed and understood by and between the parties of this contract that the lengths of the different types of construction as shown or in any way indicated on the Contract Drawings are approximate only, and that owing to the lack of definite information the Company is unable to locate the junction points of the various types or the relative amounts of each type; and no claim for damage or any additional expense or payment shall be made by the Contractor against the Company on account of any such surplus or deficiency of any type of construction from the amount shown or in any way indicated on the plans.

PENNSYLVANIA, NEW JERSEY AND NEW YORK RAILROAD.

20. The unit prices hereinbefore named shall be used in making progress estimates of materials and labor in the completed work.

21. It is mutually agreed by the parties to this contract that the Contractor shall keep on hand at places approved by and under the control of the Engineer, such amounts of cast iron or cast steel tunnel lining, cast iron screw pile sections, cast steel screw pile points and bolts as the Engineer may from time to time require and payment therefor shall be made on each progress estimate, for such materials thus required by the Engineer as are actually on hand at the end of the calendar month, at the prices named in the following Schedule No. 42, but this provision shall not prevent the Contractor from storing at his own cost and expense such additional amounts as he may deem proper; nor shall it relieve him from his entire responsibility for furnishing all materials at such times and in such quantities as needed for a continuous and vigorous prosecution of the work.

Schedule No. 42.

For iron and steel castings delivered in such quantities and at such places at or near the work as the Engineer may require:

	Unit.	Unit Price.	
		\$	¢
Cast iron tunnel lining.....	lb.	.....	.....
Cast steel tunnel lining.....	"	.....	.....
Cast iron screw pile sections.....	"	.....	.....
Cast steel screw pile points.....	"	.....	.....
Bolts .....	"	.....	.....

22. Payments under the foregoing provisions shall be subject to the following conditions:

(a) The unit prices include the cost of materials and labor other than those mentioned in the schedules, but required by the plans or specifications.

(b) The amounts of excavation in air of normal pressure shall be measured by the product of the area defined by the Standard Section Lines, as shown on the Contract Drawings and described in the specifications, multiplied by the length of the excavation made.

(c) The amounts of excavation in compressed air for tunnels driven with shields, shall be measured by the product of the area within the exterior surface of the cast iron or cast steel lining, multiplied by the length of the

completed lining and no excavation in advance of the completed lining or outside thereof shall be estimated.

(d) Where concrete or rock packing is required to be built against the surface formed in excavation the amount shall be calculated from the areas defined by the Standard Section Lines as shown on the Contract Drawings and described in the specifications.

(e) Except as above provided, only actual weights or actual net measurements of materials in place, calculated from the Contract or Special Drawings shall be estimated and paid for, notwithstanding any local or foreign custom to the contrary.

(f) The total amounts of iron and steel castings and bolts delivered but not placed in the work, which may be estimated and paid for shall be fixed from time to time by the Engineer, and no such materials in excess of the amounts so limited shall be carried into the estimates.

(g) If in consequence of changes of plans or otherwise, materials or work not named in the foregoing Schedules are required by the Engineer to be furnished, payment is to be made therefor at net cost of such materials and labor, duly ascertained, determined and certified by the Engineer, plus an allowance of ten per cent. on account of use of tools and all other plant, superintendence and all other miscellaneous expenses; or in lieu of such payment for net cost plus ten per cent., the Engineer and Contractor may in writing agree upon a fixed amount or fixed rates to be paid by the Company for such materials or work.

(h) If the Company so elects, it may, upon giving the Contractor ten days written notice, require the Contractor to effect the complete disposal of all excavated materials or any part thereof, paying therefor at the rate of cents per cubic yard, measured as hereinbefore provided for measurement of excavation.

23. Monthly payments based on the estimates prepared and certified by the Engineer and on the unit prices hereinbefore specified shall be made to the Contractor on or about the 15th day of each calendar month for work performed up to the end of the previous calendar month. Ten per cent. shall be retained until six months after the Engineer shall have in writing certified the completion of the work and the railroads in the tunnel and approaches are opened and put in use for regular and usual public traffic. If at the end of said period of six months the Contractor shall have paid to the Company the cost of all work done by it in maintaining the works in

perfect condition during their continuous use for public traffic to the satisfaction of the Engineer, one-half of the retained percentage shall be paid to the Contractor. At the end of another period of six months, if the costs of like maintenance shall have been paid by the Contractor, the remaining one-half of the retained percentage shall be paid to him, and the Contractor expressly agrees that the Company may maintain, at the Contractor's own proper cost and expense during their continuous use for public traffic, the works in perfect condition for such period of twelve months after such certified completion of the works, but no portion of the said retained ten per cent. shall be paid or considered due the Contractor until he shall have shown to the satisfaction of the Engineer that the work is free from all liens, claims and demands for labor, materials and supplies, as hereinbefore provided.

24. If the Company at any time fail to make a monthly payment at the time hereinbefore specified, such failure shall not be held or deemed to vitiate or avoid this contract, but in such case the Contractor shall be entitled to interest at the rate of ten per cent. per annum on the amount unpaid until payment shall have been made, and the Contractor shall have the right to stop all work until so paid; and in that case the date for the completion of the work shall be deferred by a period equal to the period of such stoppage.

25. The Company may at any time suspend the work provided for in this contract, and in such case, if the period of suspension does not exceed 6 months, may declare an extension of time for its completion equal to the period of such suspension; or at the option of the Company, it may pay the Contractor for such materials delivered up to that time for the permanent work as may not have been estimated and paid for previously and also the accrued ten per cent. reserved; and furthermore may take possession of the Contractor's plant, paying for the said plant an amount to be fixed and determined by the Engineer whose decision shall be binding on, and immediately executed by both parties, and the Contractor shall have no claim for loss or damages on account of such suspension. If, however, the period of suspension exceeds 6 months, the Contractor shall not be obliged to accept an extension of time for completion of his contract, but shall be entitled to payment for materials delivered and the reserved 10 per cent. and an award by the Engineer as above provided.

26. The Contractor agrees that he will promptly pay for all labor, services, supplies and materials used in or about the construction and work herein provided for, and all of said payments shall be made at least as often as payments

are made by the Company to the Contractor, and should said Contractor at any time fail so to do, the said Company may at its option, and it is hereby authorized to retain out of the consideration herein agreed to be paid by said Company to said Contractor such amounts of money as the Engineer may deem sufficient to pay the same, or to secure said Company from loss by reason of such non-payments. Before final settlement is made between said parties under this contract, the Contractor agrees that he will produce satisfactory evidence to said Company that all labor, services, materials and supplies aforesaid have been fully paid for, and that all of the construction herein mentioned and all other property of said Company are free and clear from all liability and liens of every kind arising out of the performance of this contract, and that no lawful claims or liens as aforesaid can be made or filed against the Company or its property. No payment shall in anywise lessen the responsibility of the Contractor for the full and final completion of the entire work; neither shall it exempt said Contractor from liability, at his own cost and expense, to replace the work if afterwards found to have been done ill or not done according to the plans and specifications of this contract, either in work done or in materials furnished.

27. The said Contractor agrees to protect and hold harmless said Company and all of its property from any and all kinds of liens accruing to or to accrue for labor and services performed and for materials and supplies furnished or for any of the same, in or about the work and construction herein provided for.

28. The Company shall not be liable for any loss or damage which may happen to said work, or to any part thereof, from any cause whatever, or for any loss or damage of any of the materials, tools, implements or other things used in doing said work. The Contractor shall be held solely responsible for all deaths, personal injuries and damages to property occurring on account of and during the performance of the work hereunder and shall indemnify and save harmless the Company from liability upon any and all claims for damages on account of such deaths, personal injuries and damages to property and from all costs and attorneys' fees in suits which may be brought against the Company for such deaths, personal injuries and damages to property; and said Contractor shall and will, at his own expense, make and maintain such hospitals, medical attendance and other provision as may be necessary for the safety and efficient and full protection of all persons and property during the performance of said work. Should there be any unsatisfied claims for deaths,

personal injuries or damages to persons or property at the time when the final estimate for the work is made and returned, the Engineer shall have the right to retain out of said final estimate a sum in his judgment sufficient to protect the Company in regard to all unsatisfied claims as aforesaid; and in case the amount thus retained from the Contractor on said final estimate should be insufficient to pay the amount of such claim when adjudicated, the Company may sue for and recover from the Contractor the amount or balance, as the case may be, as a debt from the Contractor to the Company.

29. The Company will secure right of way where the line passes under private property and will place the Contractor in possession of the land designated on Contract Drawings Nos. 1001, 1027 and 1044, as sites for shafts and plants, but if delayed by legal injunction or otherwise, the Company shall not be held liable to the Contractor for damages or loss resulting from such delays; but the Contractor shall be entitled to such extension of time for the completion of work under this contract as the Engineer may certify to be just and equitable.

30. The Contractor shall obtain all permits required from the City or other governmental authorities and shall be solely responsible for penalties incurred and imposed for violation of any laws or ordinances of the City or other Governments.

31. The Contractor shall be solely responsible for all royalties or other sums payable for the use of patented inventions and shall keep the Company indemnified against all claims and demands in respect to the use or infringement of any inventions, whether the specifications require such to be used or not.

32. The plant and every part thereof and all and every material and thing to be used in or for the construction or maintenance of the work shall, as soon as placed upon any land or premises belonging to the Company, or upon any land or premises temporarily held or retained or fenced in during the construction of the work in connection with the same, absolutely be and become the property of the Company and shall not be removed therefrom without the written permission of the Engineer being first obtained. When and so soon as the work comprised in this contract and specifications is ready to be opened for public traffic and all the obligations of the Contractor to the Company are fulfilled and when the release in full by the Company to the Contractor shall have been executed, and not before, the Company will give and deliver to the Contractor, for his own use and benefit, all the plant and surplus materials

placed by the Contractor and then remaining upon the work or upon the land or premises temporarily held as aforesaid which the Engineer shall in writing certify are not required for the permanent purposes of the work, and the Contractor shall immediately remove and take away the same, leaving the work and premises in perfect repair, clean and in good condition, all at his own cost and expense.

33. It is distinctly understood and agreed between the parties hereto, anything herein to the contrary notwithstanding, that if for any cause the work to be done hereunder by the Contractor, or any part thereof, shall be impeded or delayed by the order of any court in any proceeding at law or in equity now pending or hereafter to be brought, there shall be no right on the part of the Contractor to demand or recover any damages or to receive any additional compensation from the Company, on account of such impediment or delay; but that any loss or damage caused by such impediment or delay shall be borne exclusively by the Contractor and the Company shall not be responsible in any way therefor. It is further understood and agreed, however, that in case the work or any part thereof shall be impeded or delayed as aforesaid, then the time within which the Contractor is required hereunder to complete the work, or any part thereof, so impeded or delayed, shall be extended for an additional period equal to that for which the same shall have been so impeded or delayed.

34. In case the Contractor shall fail to complete the work hereunder in accordance with the specifications and to the satisfaction of the Engineer within the time herein agreed upon, the Contractor shall and will pay to the Company a sum equal to $\frac{1}{50}$ of 1 per cent. of the amount paid or to be paid him for the entire work, for each and every day the time consumed in said work and completion may exceed the time herein allowed for that purpose, which said sum in view of the difficulty of ascertaining the loss which the Company will suffer by reason of delay in the performance of the work hereunder, is hereby agreed upon, fixed and determined by the parties hereto as the liquidated damages that the Company will suffer by reason of said delay and default and not as a penalty; and the Company shall and may deduct and retain the amount of such liquidated damages out of the moneys which may be due or become due to the Contractor under this agreement.

35. It is further agreed that if the Engineer shall at any time certify that in his opinion sufficient and suitable machinery, tools, plant and materials are not provided or that a sufficient number of workmen are not employed in the execution of the work under this contract, or that the work or any part thereof

is not being carried on with due diligence and dispatch to ensure its completion within the time specified in the contract, or if the Contractor shall not comply with such orders as may from time to time be given by the Engineer with respect to the work, the Company may give the Contractor written notice requiring him to provide such additional machinery, tools, plant or materials, or to employ such additional number of workmen as the Engineer shall think reasonable for the due execution of the work with greater diligence and dispatch, or to comply with such orders as aforesaid, and if the Contractor shall not within 10 days next ensuing after the receipt of such notice comply in all respects with the directions thereof, or commence the things thereby required to be done and diligently proceed therewith, so far as time will admit, the Company may:

(1) Declare the Contractor to be in default; and the Company in addition to every, or in substitution for any other remedy which it may have by law or hereunder, may thereupon forthwith procure by contract or otherwise either for the Contractor, for his account and at his risk or otherwise as the Company shall determine, the completion of the work embraced in the contract, or, in any case where the Company so elects, the construction or provision of any part of such work; and the Company may to the extent of the cost of such completion of the work embraced in the contract or of such construction or provision of any part thereof and interest on such cost, withhold and apply thereon any moneys otherwise due or to become due by the Company to the Contractor, and the Contractor shall be liable to the Company and shall as the Company may from time to time require, forthwith pay to the Company the excess, if any, of the cost to the Company of the completion of such construction of the work embraced in this contract or of such construction or provision of any part thereof over the amount payable to the Contractor therefor under the terms of the contract. And such completion, performance or provision by the Company shall not release or discharge the Contractor from liability with respect to his paying the costs of maintenance of the work after completion as herein stipulated, or the remainder of the construction, or any other liability hereunder, or

(2) Declare this contract at an end except as to liability of the Contractor hereinafter in this paragraph provided, and may make a new contract for construction with other parties, upon such terms as the Company may deem proper; the same to provide among other things that the new contractor shall allow for so much of construction as has been already completed, a reasonable

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amount to be prescribed in such new contract or to be ascertained as in such new contract to be provided; and in such case the Contractor shall pay the Company for all damages which the Company shall sustain by reason of such failure, including the excess, if any, of the amount which the Company shall pay the new contractor over the amount it would have had to pay the Contractor, party hereto, for the same work and materials, together with the amount, if any, which shall be due the Company by reason of the delay in completion of the construction and completion of the entire work, and

(3) The Company may also proceed, as to the Company may seem proper, upon the bond given by the Contractor for the due performance of this contract, and

(4) The Company may also bring any suit or proceeding for injunction or to recover damages or to obtain any relief or for any purpose proper under this contract.

36. The Contractor hereby agrees to file with the Secretary of the Company, within 10 days from the date of this contract, a penal bond in the sum of..... dollars (\$) with good and sufficient sureties thereon, satisfactory to the Company, conditional for the faithful performance of this contract; should the Contractor fail to do so, this contract may be cancelled at the option of the Company.

IN WITNESS WHEREOF, this contract has been executed by the parties hereto the day and year first above written.

Signed

“

“

“

“

“

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The Index is not a part of the Specifications.

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